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Metal Cutting Tools.

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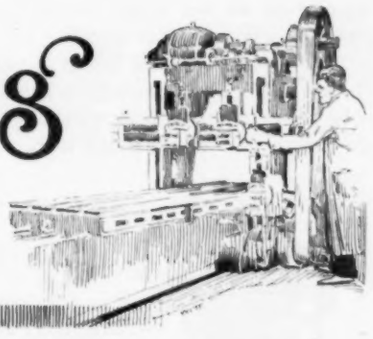
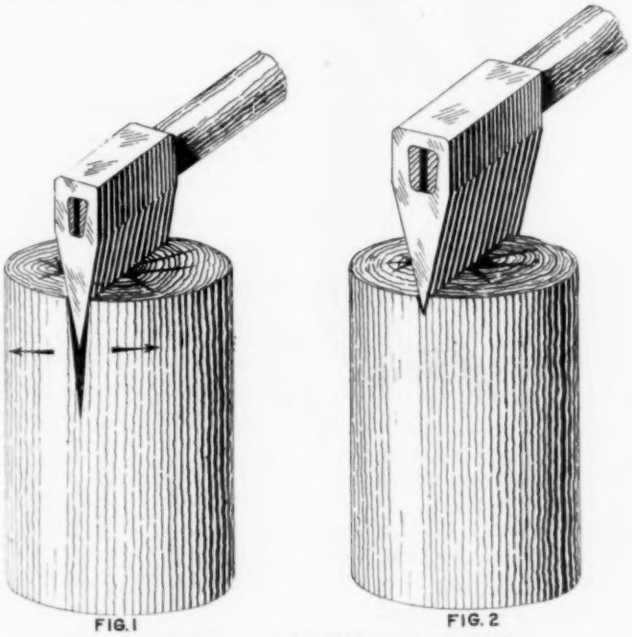


I. Analogy Between Actions of Razor, Hatchet and Metal Cutting Tools — Formation of Chips — Elementary Considerations in the Construction of Simple Tools

ALL metal cutting tools are essentially knives, very much modified, and sometimes almost unrecognizable, but still, in all essentials of their action and functioning, the same as a pocket knife, a hatchet or a razor. To study the action of a metal cutting tool one should first study the action of the ordinary knife.

The action of a hatchet splitting a log is illustrated in Fig. 1. The hatchet has penetrated a certain distance, and the pressure on the two halves of the log caused by this wedge has made an opening which extends further down than the cutting edge of the hatchet. The log is splitting; and it should be noted that the point where the splitting ends is some distance away from the cutting edge of the hatchet. It is, therefore, not the edge of the hatchet which does the splitting, but the sides which bear against the wood. When the splitting has proceeded so far a dull wedge might be placed in the partially split log, the hatchet



FIGS. 1 AND 2. ACTION OF A HATCHET

might be removed, and the splitting might be finished by pressure on the wedge. This shows that the sharp cutting edge is not needed for the action of splitting. In Fig. 2 is shown the purpose of the cutting edge of the hatchet. In this illustration the hatchet is shown as just entering the wood. The cutting edge of the hatchet has compressed the wood, which allows it to enter a short distance. In entering the bevel sides of

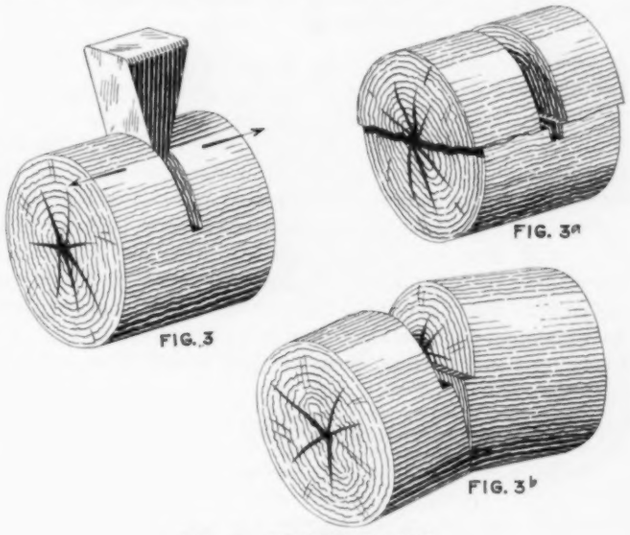


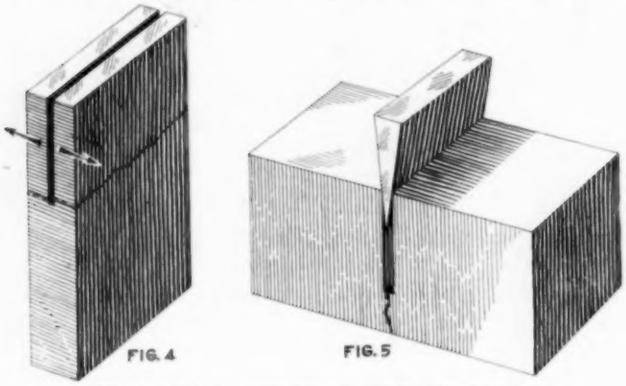
FIG. 3. WEDGE ACTION

the hatchet are forcing the two halves of the log apart. If the blow is not sufficiently hard, or the log is too strong, the only result will be that a little nick or kerf is made in the top of the log; but if sufficient pressure is brought to bear on the hatchet, in other words, if it has been swung with sufficient force, the bevel sides of the hatchet will bring the two sides of the log so far apart that the log splits. From this moment on the cutting edge of the hatchet ceases to work, and all the work is now being done by the sides. The single blow of the hatchet performs two different operations: it compresses the wood, which allows it to enter, and it forces the two halves of the log apart, which makes it split. The two operations are the entering and splitting. It should be noticed that, in this case, the entering is caused by compressing the material, and the splitting by putting the material in tension.

The action of the wedge does not always cause the material to split in the manner illustrated in Fig. 1. If a piece of wood is sawed in, as shown in Fig. 3, and a wedge is driven into the saw-cut, various things

may happen. The top portion of the piece of wood on either side of the saw-cut may be driven out, as shown in Fig. 3a, or it may split, as shown in Fig. 3b, depending on the direction in which the piece of wood has the greater strength.

If we should take a piece of cast iron, of the form as shown in Fig. 4, and make a saw-cut, then drive a wedge into this cut, the piece would probably break somewhat as shown in Fig. 3a; but if it had the form of Fig. 5,



FIGS. 4 AND 5. TYPES OF BREAKS CAUSED BY WEDGE ACTION

it would probably break as shown in Fig. 3b. Again, the nature of the break will depend on the plane of least resistance. A break as shown in Fig. 3b or Fig. 5 would be a break caused by tension; a break as shown in Fig. 3a or Fig. 4, would be a break caused by shear or bending; the probability being that with conditions as shown in Fig. 4 bending would cause the break, and that with the condition shown in Fig. 3a the break would be caused by direct shear. However, it should be noted that the material is first subjected to compression to provide an entrance for the wedge, unless such an entering position had been first provided by making a saw-slot, for instance.

Controlling the Cut

In the illustrations given above, the tool was entirely free, and so was the work. We imagined that a log was set on the ground, and a man swung an axe. If, for some reason or other, the fiber of the log was not straight, the log would split in the direction of the fiber, and the two halves of the log might have plane, or curved, or irregular surfaces; and, furthermore, though the axe might have entered the top of the log exactly on the diameter, the bottom of the log might be divided in an entirely different fashion. There was nothing to guide the axe except its momentum, but there were many causes to make it deviate from its original course. We find this unguided condition of the tool in practically all cases where we use knives, and the only means we have of controlling the nature of the cut when we use a knife is to grasp the knife and the work firmly and depend on our muscle. Where a knife is used for metal cutting the resistance offered by the metal is, as a rule, so great that our muscles are no longer sufficient to guide the tool even approximately. In old lathes the tool was provided with a long handle which was firmly clasped between the arm and the body, or supported under the shoulder, while the left hand would grasp the tool close to the cutting edge and guide the tool point. In this manner light cuts could be taken, provided the operator was skillful, strong, and with steady nerves. But the cuts we take nowadays would make such a manner of guiding the tool utterly impossible; and this brings us to the two chief differences between the ordinary knife, as we use it, and the metal cutting tool.

Metal cutting tools are used almost exclusively in machines, and provision is made in such machines to hold the tool against undesirable movements; or, we might say, the tool is held in a rigid manner. We must not forget, however, that this rigidity is by no means perfect, and that most of the problems of turning, boring, drilling, planing, milling, and so on, are caused by the fact that this rigidity is only approximate. The further the manner of holding the tool departs from absolute rigidity, the greater and more complicated are our problems of machining. The same holds true of holding the work. What we aim to obtain is a positive relation between tool and work, notwithstanding that the tool is moving relative to the work; so that whether the tool or the work lacks rigidity makes no difference—we will have a difficulty on our hands unless the relative rigidity of tool and work are maintained.

Differences Between Metal Cutting Tools and the Knife

The second point in which the metal cutting tool differs from the knife is the angle of the wedge. A razor is ground in such a way that the two sides of the wedge form a very small angle with each other; a pocket-knife has

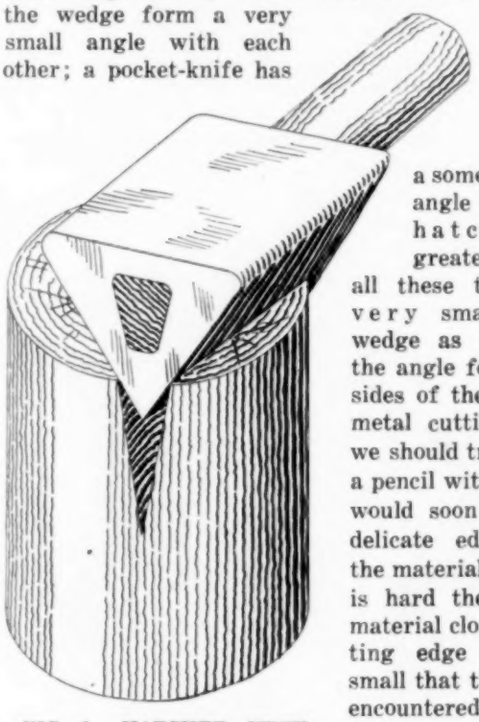


FIG. 6. HATCHET WITH EXTREMELY LARGE WEDGE ANGLE

a somewhat greater angle of wedge, a hatchet a still greater angle. But all these tools have a very small angle of wedge as compared to the angle formed by the sides of the wedge of a metal cutting tool. If we should try to sharpen a pencil with a razor, we would soon destroy the delicate edge. Though the material of the razor is hard the amount of material close to the cutting edge is so very small that the resistance encountered in sharpening a pencil is sufficient to break it down. If we should try to cut crosswise through a piece of hardwood with our pocket-knife, hitting it on the back with a hammer to expedite matters, the cutting edge of the pocket-knife would soon break down, though it is much stronger than the razor.

If we attempt to chop down tenpenny nails with our hatchet, we'll nick the hatchet, though its material is much harder than that of the tenpenny nail and its cutting edge much stronger than that of the pocket-knife. In a tool capable of cutting metal, we need an angle of the wedge so large that it almost approaches

a right angle and, to the casual observer, the tool loses its appearance of a knife. Metal cutting tools are used with wedge angles varying from almost 90 deg. to less than 40 deg. Hatchets and axes may be used with wedge angles of more than 40 deg. So there is a continuous increase in the cutting angle from a knife (or a razor blade which is close to zero) to the heavy roughing lathe tool which is close to 90 deg. The difference in action between the pocket-knife and the heavy lathe tool is merely a matter of degree or amount. Yet one effect may be so large in one tool and so small in the other, and another effect so small in the first tool and so great in the other, that it might seem at first glance as if the two tools were governed by entirely different laws and conditions.

In Fig. 6 a hatchet is shown with a wedge angle somewhat like the angle of a metal cutting tool. It will readily be seen that though such a hatchet would be awkward to handle it would still split wood and do it in the same fashion as an ordinary hatchet.

In Fig. 7 a log is shown clamped down on a solid support, but the tool used to split the log is not guided, and as a result the plane of cleavage still follows that of least resistance. In Fig. 8 the log is again clamped down, but this time the tool is guided. When the tool enters, it may split the log along the plane of least resistance, which is shown by the dotted line, but, as the tool gradually descends, it is bound to cut off everything which is left to the right of the plane *AB;* so that a clean cut will

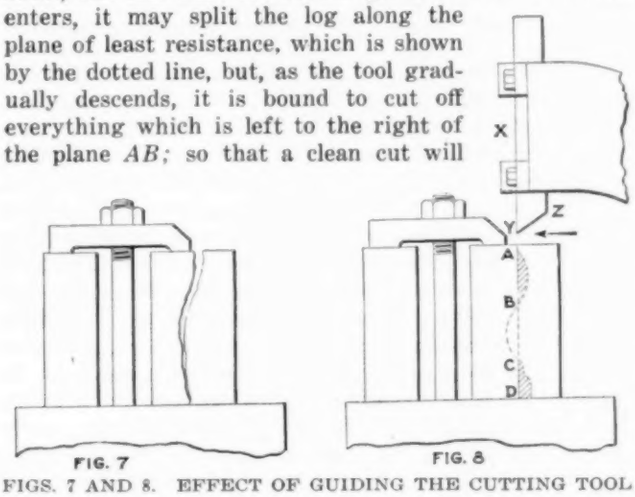


FIG. 7 FIG. 8

FIGS. 7 AND 8. EFFECT OF GUIDING THE CUTTING TOOL

be made wherever the cleavage plane is to the right of *AB*, whereas a hollow remains where the cleavage plane is to the left of *AB*.

In this figure the angle *XYZ* of the tool, the wedge angle, is formed by two planes, one of which, *XY*, is parallel to the plane of movement of the tool. It will also be noticed that as the tool descends, a pressure is brought to bear against *YZ* tending to force the tool to the left. However, our tool is supposed to be rigidly guided, that is, it can move up and down, but in no other direction. Therefore this pressure exerted against *YZ* only forces the tool against the guide but not against the standing part of the log. Of course such a condition never prevails in practice, and we only suppose this condition to exist here in order to separate in our minds the varied phenomena which occur when we cut metal under practical conditions.

In Fig. 9 the log again is clamped and the tool is guided, but this time the plane *XY* of the tool is not parallel to its plane of movement. The point *Y* strikes the point *A* of the log and makes an impression, and the log will begin to split from this point on, either along a straight line *AB* or along some other plane, but in any case starting at *A*. A little later the plane *XY* of the tool bears against the log and as the log cannot move to the left nor the tool to the right the tool can only proceed by crushing the material. In this case the pressure is greater between the standing part of the log and the tool than between the split-off part

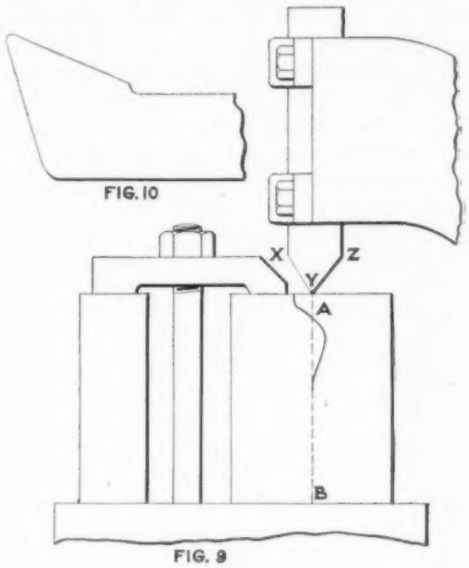


FIG. 9

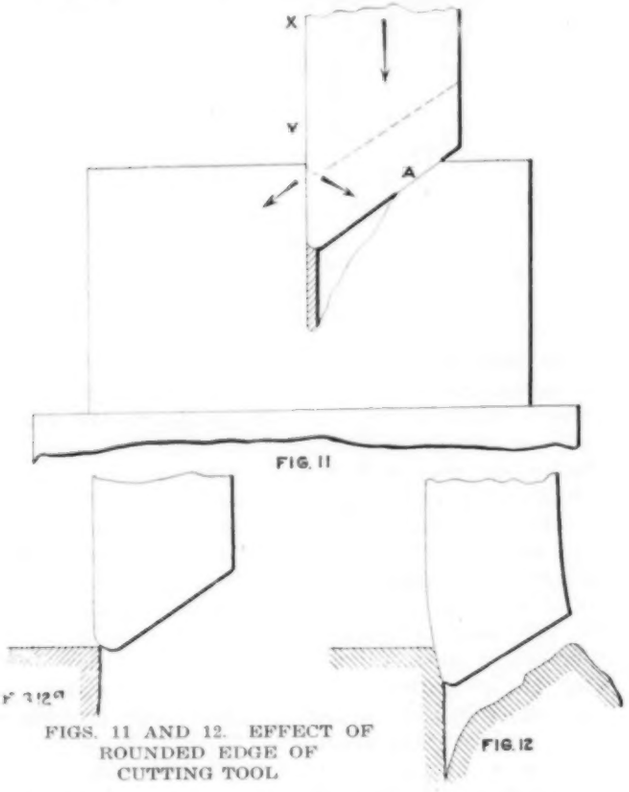
FIGS. 9 AND 10. ACTION AND MAGNIFIED SHAPE OF METAL-CUTTING TOOL

and the tool, and there will be a tendency to force the tool to the right. It is this condition which always exists in metal cutting tools, though not to the extent shown in the illustration.

Referring again to Fig. 8, the tool was shown to be perfectly sharp; that is, two planes, *XY* and *YZ*, came together at *Y* and formed an angle. In reality, two plane surfaces of a piece of metal never form a true angle with each other. Even if there were left only one row of molecules at the joint of these two planes *XY* and *YZ*, these molecules would have *some* size. In other words lines *XY* and *YZ* would not meet in a point, but both would be tangent to a little sphere, or some other body, according to what shape that molecule might have. It hardly need be said that even this condition cannot prevail in practice. The finest grinding wheels would make grooves in both surfaces much deeper than the diameter of one molecule, and even if this were not the case the finest cut would crumble this fine edge until enough material is left to resist the touch. As a matter of fact every metal cutting tool, when viewed under a sufficiently strong magnifying glass, shows a rounded edge and appears like Fig. 10 only not so much so. Most of the precautions we have to take in the construction of metal cutting tools arise from the fact that what we call the cutting edge is really a rounded surface. The other chief element to be considered in the construction of metal cutting tools is the fact that the work is never entirely rigidly held, and that the tool is always more or less free to move in a plane differing from the plane in which it is cutting.

We will first consider in what general manner a rounded edge of the cutting tool affects its action. In Fig. 11 the cutting tool moving in the direction of the arrow is shown splitting off a piece of the material which is supposed to be clamped rigidly. The tool is also rigidly guided. The dotted line shows the position of the tool when the splitting begins. As part

of the rounded edge tends to force the material to the left, and another part tends to force the material to the right, the plane of cleavage will be somewhere to the right of plane *XY* of the tool. The full lines show the tool after it has penetrated a considerable distance into the material. There is some material left (shown in the shaded section) which must be crushed by the tool, and therefore there will be a tendency to bend the tool toward the right. Fig. 11 represents the tool as being caught between two pieces of material. It cannot bend toward the right on account of the heavy mass of material pressing against the tool at *A*, but if the condition were as shown in Fig. 12, where the right-hand material has either moved entirely out of the way or else has been broken up to such an extent that it presses no longer against the tool with con-



FIGS. 11 AND 12. EFFECT OF ROUNDED EDGE OF CUTTING TOOL

siderable force, then the tool will bend as shown in the illustration. It will bend until only a small amount of material has to be crushed, as shown in Fig. 12a, where the point of the tool is shown much enlarged. Under these conditions there is not only a pressure against the point or cutting edge of the tool, but also against plane *XY*.

If the material which is being split here were of a brittle nature, instead of being a log of wood, the movement of the tool against the clamped part of the material and under heavy pressure would wear the back of the tool away and would also wear away part of the cutting edge. In the course of time this cutting edge would have such a small amount of round left, that it would no longer be able to resist the pressure of the material which it must crush, and the edge would break off. It is this condition which compels us to give *clearance* to a metal cutting tool.

Before looking further into this matter, we must now consider what happens if the plane of cleavage, which up to now has always been represented as going from top to bottom, should follow some other direction. Fig. 13 represents this condition. *ABCD* represents a block of wood of which the fiber runs as shown. The block is supposed to be securely clamped and the tool rigidly guided. As soon as the tool has penetrated

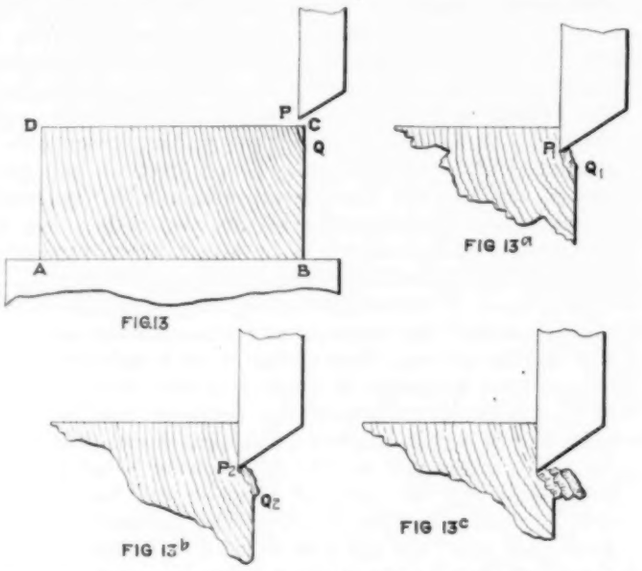


FIG. 13. "CHIP" FORMATION IN CUTTING WOODEN BLOCK

a short distance it will split off a piece along the line *PQ* and the log will appear as shown in Fig. 13a. After penetrating a short distance further it will again split off a piece along the line P_1Q_1. Penetrating still further, it will now split off a piece P_2Q_2, as shown in Fig. 13b, and so forth. If the fiber of the wood is of a tough nature it may well happen that the pieces which are then split off are still hanging together by a few fibers, and the three pieces which have been split off so far, will appear as shown in Fig. 13c. This is the way in which, generally speaking, a chip is formed when we cut metal.

In Fig. 14 a steel plate is shown clamped on the frame of a guillotine shear of which the knife is just touching the work. The downward movement of the knife will deform the plate as shown in Figs. 14a and 14b, and when the depression is down to about one-third of the thickness of the plate, the right-hand portion is completely sheared off from the remainder. If instead of a plate we have a heavy chunk of metal, as shown in Fig. 15, the same thing would happen again provided the machine were strong enough, the tool were strong enough, and sufficient force were exerted on the tool.

A different action would take place if we had a condition such as shown in Fig. 16. Here again a

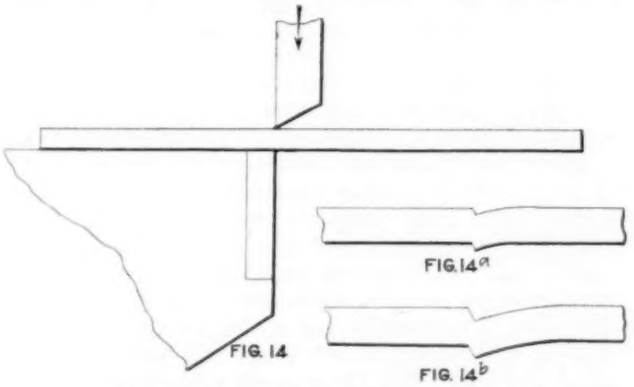
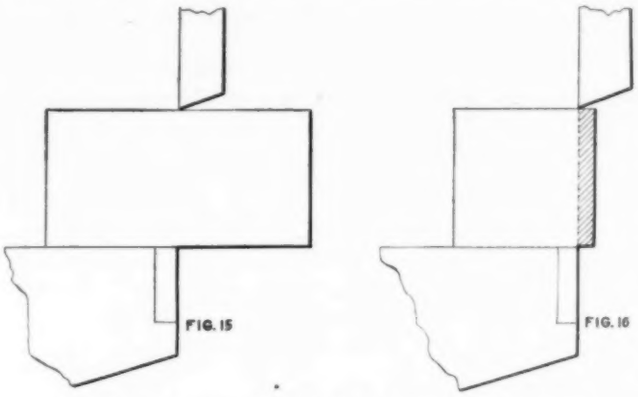


FIG. 14. SHEARING A METAL PLATE

heavy chunk of metal is clamped rigidly to the shear-frame, but that portion of the material which overhangs the frame is rather small (shown in the shaded section).

The shear blade comes down and presses on the work. Due to the fact that the bottom of the shear blade



FIGS. 15 AND 16. SHEARING HEAVY BARS WITH DIFFERENT OVERHANGS

makes an angle with the horizontal plane, the blade must penetrate into the work quite a considerable distance before the maximum pressure is reached. Finally a pressure is reached sufficient to split off a piece of material, after which the shear blade proceeds on its way, gradually exerting a greater and greater pressure on the remaining metal, until a sufficient pressure is reached again to split off another piece of material. It will be seen, therefore, that under the above conditions the entire piece of material is not split off at once, but by fractions. Fig. 17 represents the action of the shear blade and the formation of the chips in an elementary way. Fig. 17a shows the condition after one chip has been formed, Fig. 17b shows two fractions of chips, and Fig. 17c shows three. However, in these illustrations, no account is taken of the fact that the little pieces of metal are compressed before they are split off. They do show, nevertheless, the following features:

First, the final chip is made up of a number of sections.

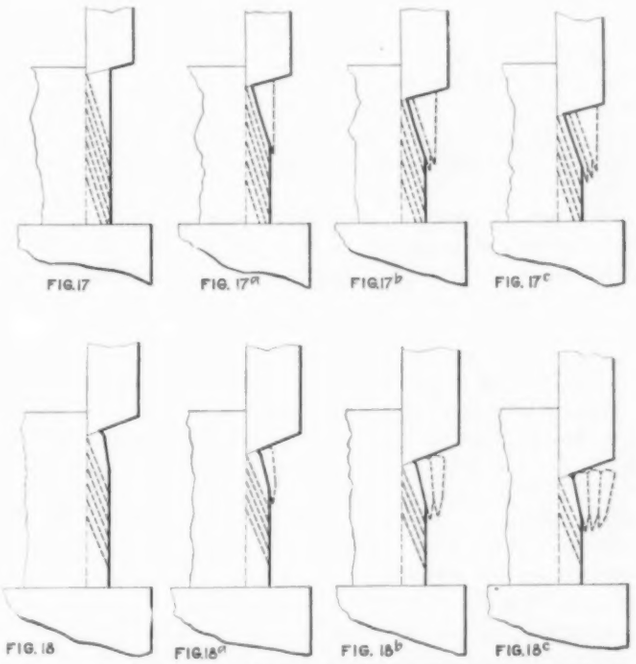
Second, the previous section slides over the next section, when this next section is being formed.

Third, after the sections have been separated from the material, they are compelled to slide along the bottom of the shear blade.

Fourth, the apparent thickness of the chip is not the thickness of the piece of material which is being removed from the main mass, but the length of the line along which the chip is removed from the material.

In Figs. 18, 18a, 18b and 18c, the formation of the chips is again indicated along the same lines as in Fig. 17, except that now the effect of compression is considered. Fig. 18 shows the shear blade in a position after the first section has been removed, and about ready to compress the second section. Fig. 18a shows this second section compressed and about to be split off. It shows the increased width of the top part of that section. Fig. 18b shows two sections alongside of each other, and Fig. 18c shows three sections cut off. Due to the fact that the top part of these individual sections is no longer bordered by two parallel planes, but rather by two planes which converge downward, a succession of these sections will present a curved surface at the top. Furthermore, the broad tops of these sections join each other in a practically continuous surface, whereas the bottom parts which are more knife-like in shape do not join. Again, as the tops of the sections are compelled to move along the bottom of the shear blade under heavy pressure these tops are smoothed down or polished, whereas the bottoms will stand apart and not having been subjected to this sliding motion under pressure the complete chip will present a ragged appearance at the bottom. Particular attention is called to the fact that the natural form of the complete chip will be a curve, regardless of whether the tool is curved or not.

In the foregoing illustrations the plane of cleavage was shown at right angles to the bottom of the tool. This was done merely for the sake of keeping the discussion free from complications. However, there is no reason to expect that the plane of cleavage must be as shown. In Fig. 19 OA is the bottom of the tool, making an angle α with the horizontal line OX. The section $OBCD$ is about to be removed, and the plane of cleavage makes an angle β with the vertical line. If the width of the piece of material to be removed is a, then the length of the line of cleavage, BC, is a cosec β. If the width of the piece to be removed is w, then the section to be sheared off is wa cosec β; and if the compressive strength of the material per unit of area is P, and we may assume that the ultimate shearing strength is $4/5P$, then the pressure required to shear off this section along the line DC is $4/5Pwa$ cosec β. This pressure will not be reached until the tool has compressed the section far enough to cause this amount of pressure in the direction BC or CD, that is, when the line OA has reached the position BQ. The relation of these forces will be considered more in detail in another chapter. Our present aim is to show that a plane of cleavage is formed due to the vertical pressure of the tool, and that the direction of this plane of cleavage is dependent on a number of items. One of the items, we would think, would be the angle of the tool, yet so far this



FIGS. 17 AND 18. FORMATION OF CHIPS WITH THE EFFECT OF COMPRESSION IGNORED IN FIG. 17 AND ALLOWED FOR IN FIG. 18

angle has not appeared in the considerations. However, looking at Fig. 19, we see that the amount of material *OBR* had to be crushed before the section *OBCD* would split off and therefore that the tool had to travel from *O* to *B* before this splitting action occurs. If the angle of the tool had not been α, but if the bottom of the tool had been along the line *OA*, we would still have needed a contact of the tool up to the point *R* before a section would have split off. In other words, the tool would have stood in the direction RB_1 instead of *RB*, and the section split off would have been the section OB_1C_1D, which is a much larger section than we had before. Yet the pressure required to split off this section is no more than that required for *OBCD*. Leaving out of consideration, for the present at least, a number of other items this much is clearly shown: that a change of the angle α affects the amount of metal removed for the same amount of power consumed.

Variation of Pressure

Another point of great importance to be mentioned here is the fact that the pressure required for removal of chips is not uniform but fluctuating. If we leave out of consideration the power required for moving the individual sections of the chip one over another, and also the power required for moving these sections along the bottom of the shear blade, we find that at the beginning of the removal of a section the pressure is zero, gradually climbing up until a maximum pressure for compression is reached. At that moment the splitting off begins which is a shearing action. For some little time this shearing action remains constant, so that the total pressure required is made up of two items—the gradually increasing pressure for compression, plus the constant pressure for shearing. In Fig. 20 the pressure at *A* is zero, at *B* a section has been compressed and is about to be split off; its pressure of compression is at a maximum. Between *B* and *C* there is a combination of pressure of compression on the next section and shear on the previous section, the shear being constant, while the compression fluctuates from zero to a maximum. In diagram 20a the height of the line *AB* above the base line *XY* represents the pressure required for shear, and the zigzag line *CD* represents the fluctuating pressure of compression, so that the total pressure will be represented by the line C_1D_1. This fluctuating pressure alone would account for many of the phenomena we observe in the cutting of metals.

The set of conditions we have pictured ourselves in the foregoing pages is met in the plate planer, a machine tool used for planing or chamfering edges of boiler plates and ship plates. In this machine the plate to be planed is clamped securely to a table, a small portion of the plate overhanging within reach of the tool. A carriage moves on a slideway parallel with the edge of the table. As a rule it is driven by a screw and has arrangements to hold either one or two cutting tools, for cutting either on one stroke or on both forward and backward strokes. The tool is somewhat wider than the work so that all conditions which we presume to exist in shearing off a piece of metal are present in this machine. It is perhaps the simplest type of machine tool, so far as the action of the tool is concerned. Applying what we have found in the foregoing pages to the tool of such a machine, we would construct it along the following lines:

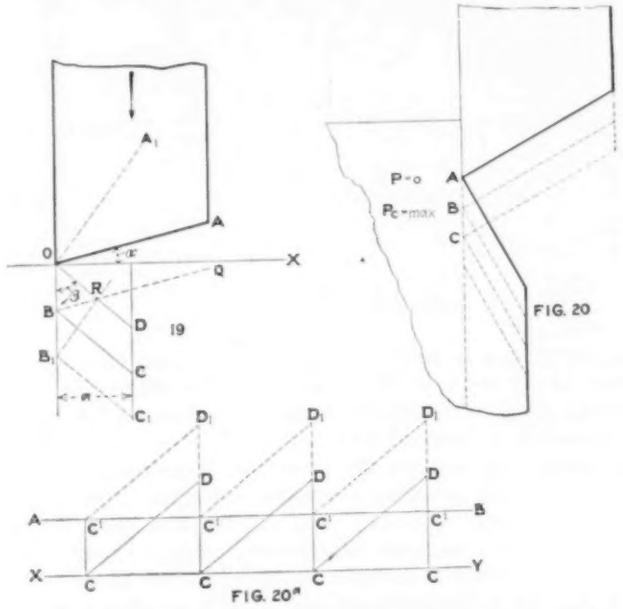
We would give it the greatest possible rake or lip, so as to reduce the amount of power required for cutting.

We would give it the least possible amount of rake or lip, so as to reduce the possibility of the edge crumbling away under the pressure.

We would make the cutting edge as sharp as possible, so as to reduce the backward pressure against the work and the consequent wear on the tool.

We would avoid a sharp edge, so as not to make the extreme edge crumble.

As will be seen two of these requirements are at war with the other two, and this is a condition which



FIGS. 19 AND 20. FORMATION OF PLANE OF CLEAVAGE

we will find all through our efforts to design tools; and, for that matter, through all our efforts to design anything. As in all other attempts at designing the engineer will have to make a compromise.

Referring back to Fig. 18c, it is seen that the sections as they are split off, place themselves in a curve the nature of which depends on a great number of conditions. The conditions shown in Fig. 18c make the curve very flat and running away from the bottom of the tool. If the plane of cleavage were more nearly horizontal, the curve of the chip would be sharper, would be bent upward, and would interfere with the bottom of the tool. This sliding of the chip against the bottom of the tool causes the chip to be burnished as has been remarked before and it also causes the bottom of the tool to wear away and become rough. If we could keep on working with such a tool after it had been worn, the wear would progress to such a point that finally the curvature of the chip would no longer interfere with the bottom of the tool. When that happens, the chip will be rough, but the tool will wear no further, at least at the bottom. This wearing away of the tool at the bottom causes the tool to appear as shown in Fig. 21. The shaded portion has been worn away, and a very small section has been left at the cutting edge. If we could know exactly how the chip will curve, we would be able to construct a tool with a curved surface, so that the chip will never interfere with it. But such a tool would be weak, and not practical. However, here again we can compromise, and grind away part of the material—not enough to weaken the tool too much, and yet enough materially to reduce

the pressure of the chip against the tool. If we should then polish this curved surface we would still further reduce the friction, and in a later chapter it will be shown how this can be done at times to great advantage.

Necessary Properties of Cutting Tools

So far we have considered in an elementary way the general form of a cutting tool, the rake, the clearance and the cutting edge, and we have seen some of the elements which tend to destroy the tool so far as the construction of the tool itself is concerned. There are other elements not yet considered which also have this tendency to cause the tool to break down. One is insufficient rigidity of tool, or work, or both; the other

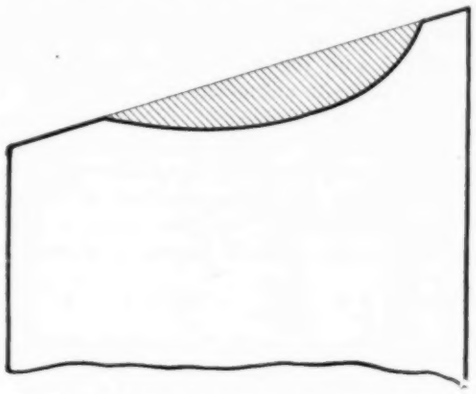


FIG. 21. SHAPE OF WORN CUTTING TOOL

is the heating of the tool. This latter element is so well recognized that we will consider it first.

Most metal cutting tools are made of hardened steel, and if hardened steel is heated above a given point it loses its hardness and is no longer fit to cut metal. Until the invention of high-speed steel the temperature to which a piece of tool steel could be heated before it lost its hardness was relatively low. This critical point is not so rapidly reached in high-speed steel tools but ultimately high-speed steel loses its hardness, too, if heated sufficiently. For a general consideration of this weakness of tool we need not make a distinction between ordinary tool steel and high-speed steel; both lose their hardness when heated sufficiently. It now remains to be seen why a cutting tool becomes hot when doing work.

A cutting tool does a variety of things when making a chip. In the first place it compresses the metal, that is, it makes the molecules in the metal assume new positions in relation to one another. In the second place it shears off the metal. In the third place it makes the sheared-off sections slide under high pressure over the remaining metal. In the fourth place it compels the sheared-off sections to slide over the face of the tool. All these actions require a certain amount of power, and this power is converted into heat. Part of this heat is carried off by radiation into the surrounding air, part is carried off by the work, another part by the tool, and still another part by the chip. If heat is generated at such a rate that it is carried off as quickly as it is generated the tool will remain at the same temperature. At first the heat is always generated at a more rapid rate than it is carried off, because the temperature of tool, chip, and work is still so low that the surrounding air or surrounding metal does not carry it off very quickly. It should be remembered that the rate of dissipation of heat is proportional to the difference in temperature between the heat giving and the heat carrying mediums. If, for instance, the surrounding air and metal are at 70 deg. F., and the cutting action causes the temperature to rise to 71 deg., then the difference between tool, etc., and the surrounding mediums being only 1 deg., it takes a relatively long time to neutralize this small difference in temperature. But if the tool, etc., should have a temperature of 570 deg., that is, a difference of 500 deg. with the surrounding mediums, then this heat would be carried away very rapidly, and as the temperature drops this rapidity of dissipation would gradually become less and less. At the very first the difference is naturally very small, consequently the rate of dissipation is low; but the rate of addition to the heat is constant, so that the temperature of tool, etc., will increase. However, eventually a temperature is reached where the rate of dissipation of the heat just equals the rate at which additional heat is given to the tool. At that time equilibrium is established. We cannot say beforehand when that time of equilibrium will be reached. This depends entirely on the rate at which the heat is given to the tool and on a number of other things, such as the temperature of the room, the section of the metal, the shape of the chip, the cross-section of the tool, etc. However, we do know that such a condition will exist. If this point of equilibrium is reached before the critical point of the tool steel, that is, before the point where it loses its hardness, then we can go on cutting without danger of softening the tool, but if this point of equilibrium lies above the temperature where the tool is softened, then the equilibrium will never be reached, and the tool will "burn out," as it is called. The moment the tool is softened it ceases to be a cutting tool and it merely rubs under terrific pressure upon the work which increases the heat very rapidly, brings it up to a red-hot condition, and the tool actually oxidizes or "burns out." This burning-out, however, is merely a secondary effect. The real thing that spoils the tool is the loss of hardness. After this point has been reached, the rest follows so quickly that it is very seldom that we will see a tool which is merely softened without having been "burned." The main difference between common tool steel and high-speed steel is the fact that the point of equilibrium is reached much later with high-speed steel than with common tool steel.

The reason why insufficient rigidity of the tool support has a tendency to break the tool down lies in the vibration caused by this condition. As many elements work together to cause this vibration, and as the relation between vibrations and the breaking down of the tool is not apparent at a first glance, we will discuss this matter more fully in a later chapter.

There is, finally, a third element which causes the tool to break down, and this is abrasion. The chip sliding along the work rubs off part of the cutting tool and at last makes the metal near the cutting edge so thin that a piece of the tool breaks off. If we wish to maintain the tool, in other words, if we wish to enable it to do the greatest amount of work before it becomes useless, we must do the following three things:

1. We must minimize the amount of heat accumulated in the tool.
2. We must support the tool as rigidly as possible.
3. We must reduce the amount of friction between the tool and the chip.

How these things can be accomplished will be shown in succeeding chapters.

Trigonometry for Toolmakers

Trigonometric Formulas as Applicable to Daily Practice — Solution of Right and Oblique Triangles—Laying Out Angles and Calculating Chords—Wire Measurement

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IN THE following columns the writer endeavors to explain in a simple manner some of the practical applications of elementary trigonometry. Superfluous matter is excluded and the formulas supplied are simple. No apology is offered for so arranging the article that simple multiplication or division is substituted for the raising of powers and the tedious extraction of roots, believing that the majority of toolmakers would prefer this course.

Remarks on the Use of Tables

No difficulty should be experienced in finding the functions or corresponding angles, if the directions usually incorporated with the tables are closely followed. If no directions are given, look for the number of degrees (if less than 45 deg.) in the top left-hand corner of the book, the name of the functions across the top of the page and the minutes down the left-hand column.

When the angle is greater than 45 deg. find the number of degrees in the bottom right-hand corner, the name of the functions across the bottom of the page and the minutes up the right-hand column. To make doubly sure of using the table correctly it should be remembered that the function of an angle less than 90 deg. is always equal to the corresponding degree-function of the complementary angle, that is:

$$\sin 30^\circ = \text{cos of } 90^\circ - 30^\circ = \cos 60^\circ$$
$$\cos 30^\circ = \text{sin of } 90^\circ - 30^\circ = \sin 60^\circ$$

and so on through all the functions.

The Solution of Right Triangles

Case I. Given hypotenuse and one side, Fig. 1. Call the hypotenuse and the known side a and b, the unknown side c and the opposite angles A, B and C respectively; then

$$\sin B = \frac{b}{a} = \frac{1.6503}{2.3} = 0.71752 = 45^\circ\ 51' \quad (1)$$

or

$$\text{cosec } B = \frac{a}{b} = \frac{2.3}{1.6503} = 1.3937 = 45^\circ\ 51' \quad (2)$$

Choose the easier form of division:

$$C = 90^\circ - B = 90^\circ - 45^\circ\ 51' = 44^\circ\ 9' \quad (3)$$

Having found B by means of formula (1) or (2) the third side may be found as follows:

$$c = \text{hyp} \times \cos B = 2.3 \times 0.69654 = 1.60204 \quad (4)$$

The usual formula for the third side, viz.: $c = \sqrt{a^2 - b^2}$, should be used only where the sides of the triangle are small numbers, the powers and roots then being taken from an engineering handbook. (5)

Case II. Given the hypotenuse and one of the acute angles, Fig. 2. Call the hypotenuse and the sides a, b and c and the opposite angles A, B and C; then

$$B = 90^\circ - C = 90^\circ - 44^\circ\ 9' = 45^\circ\ 51' \quad (6)$$
$$c = \text{hyp} \times \sin C = 2.3 \times 0.69654 = 1.60204 \quad (7)$$
$$b = \text{hyp} \times \cos C = 2.3 \times 0.71752 = 1.6503 \quad (8)$$

Case III. Given two sides, neither of which is the hypotenuse, Fig. 3. Call the two sides c and b, the hypotenuse a and the opposite angles A, B and C; then

$$\tan C = \frac{c}{b} = \frac{1.602}{1.6503} = 0.97076 = 44^\circ\ 9' \quad (9)$$

or

$$\cot C = \frac{b}{c} = \frac{1.6503}{1.602} = 1.0301 = 44^\circ\ 9' \quad (10)$$

Choose the easier form of division:

$$B = 90^\circ - C = 90^\circ - 44^\circ\ 9' = 45^\circ\ 51' \quad (11)$$

Having found C from formula (9) or (10), find the hypotenuse a as follows:

$$a = \frac{c}{\sin C} = \frac{1.602}{0.69654} = 2.3 \quad (12)$$

or

$$a = \frac{b}{\cos C} = \frac{1.6503}{0.71752} = 2.3 \quad (13)$$

When the sides are small numbers employ the formula $a = \sqrt{c^2 + b^2}$ for the third side. (14)

Case IV. Given one side (not the hypotenuse) and one of the acute angles, Fig. 4. Call the known side b, the other side c, the hypotenuse a and the opposite angles B, C, A.

$$B = 90^\circ - C = 90^\circ - 44^\circ\ 9' = 45^\circ\ 51' \quad (15)$$
$$c = b \times \tan C = 1.6503 \times 0.97076 = 1.602 \quad (16)$$

or

$$b \times \cot B = 1.6503 \times 0.97076 = 1.602 \quad (17)$$
$$a = \frac{b}{\cos C} = \frac{1.6503}{0.71752} = 2.3 \quad (18)$$

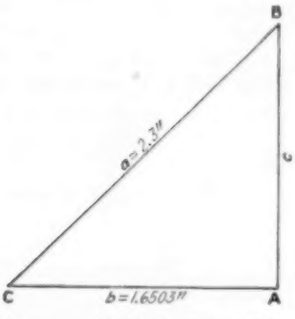


FIG. 1. GIVEN THE HYPOTENUSE AND ONE SIDE (CASE I)

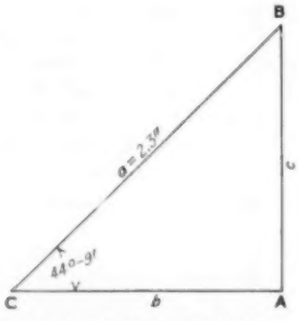


FIG. 2. GIVEN THE HYPOTENUSE AND ONE OF THE ACUTE ANGLES (CASE II)

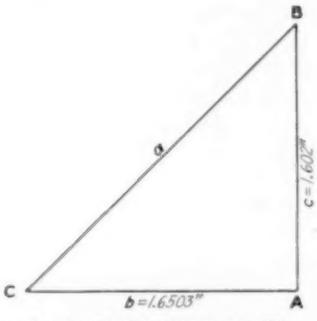


FIG. 3. GIVEN TWO SIDES, NEITHER OF WHICH IS THE HYPOTENUSE (CASE III)

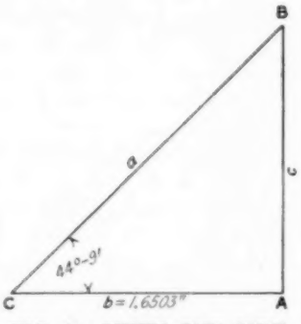


FIG. 4. GIVEN ONE SIDE (NOT THE HYPOTENUSE) AND ONE OF THE ACUTE ANGLES (CASE IV)

or $b \times \text{cosec } B = 1.6503 \times 1.3937 = 2.3.$ (19)

In the general solutions of right triangles a sufficient degree of accuracy will be obtained by working to the nearest minute and as tables of functions to minutes are available no unnecessary work is entailed.

Laying Out Angles Without a Protractor

When the edges of the work are rough and in cases where the protractor cannot be conveniently applied, it is often advantageous to lay out an angle by other means.

If a table of sines is available any of the following methods will suit:

First Method, Fig. 5. From point *A* draw base line *AB* and with the dividers set to any convenient radius draw the arc *BC*. Find the sine of half the given angle and multiply it by double the radius of the arc. With the dividers mark off this distance from point *B* and strike the chord *BD*, the included angle α being the angle required. This method is applicable to angles greater or less than 90 degrees.

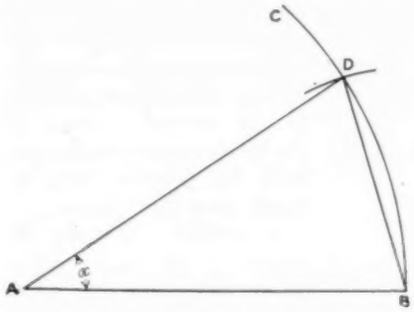


FIG. 5. FIRST METHOD OF LAYING OUT ANGLES WITHOUT A PROTRACTOR

Second Method, Fig. 6. From base line *AB* draw a semi-circle with the diameter *AB* any convenient length. Take the sine of the given angle from a table and multiply it by the diameter of the semi-circle. With the dividers set to this dimension strike the chord *BC*. The included angle α will be the required angle and the triangle included in the semi-circle will always be right-angled with its hypotenuse on the base line *AB*.

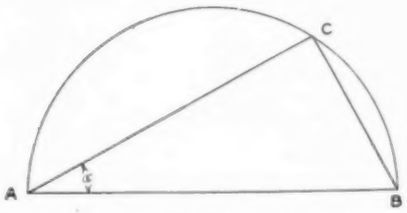


FIG. 6. SECOND METHOD OF LAYING OUT ANGLES WITHOUT A PROTRACTOR

Third Method, Fig. 7. Using a table of tangents. Draw any convenient base length *AB*. From a table find the tangent of the given angle and multiply it by the base length *AB*. The resulting dimension will be the length of the perpendicular *BC*. Join *C* to *A* and the included angle α will then be the required angle.

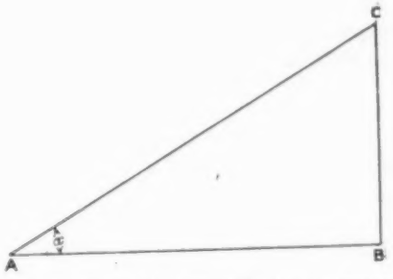


FIG. 7. THIRD METHOD OF LAYING OUT ANGLES WITHOUT A PROTRACTOR

Chord problems may be divided into two general classes, those cases where the circle is divided into equal parts, and cases where the angle is given. When the number of divisions is known, refer to a table of chords and multiply the chord opposite the number of divisions by the diameter of the circle which is to be divided. When the angle is given and the diameter of the circle is known, the chord may be found by multiplying the sine of half the angle by the diameter of the circle.

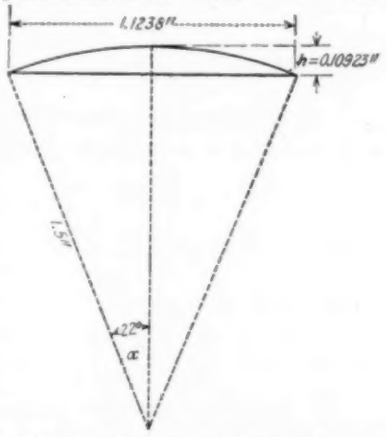


FIG. 8. DIAGRAM FOR USE WITH FORMULAS ON THE SEGMENT OF A CIRCLE

The Segment of a Circle

A large number of problems involving the calculation of the height, chord, or radius of a segment, occur in the work-shop, notably in connection with male and female gages, worm-gear blanks, and corrections for the addendum and chordal width of gear teeth. Necessary formulas are supplied and should be used in conjunction with the diagram, Fig. 8.

Chord and radius given:

$$\sin \alpha = \frac{\frac{1}{2} \text{ chord}}{\text{radius}} = \frac{0.5619}{1.5} = 0.3746 = 22° \quad (20)$$

and

$$\text{versin } \alpha \times \text{radius} = h = 0.07282 \times 1.5 = 0.10923 \quad (21)$$

or

$$(1 - \cos \alpha) \text{ radius} = h = 0.07282 \times 1.5 = 0.10923 \quad (22)$$

Radius and height of segment given:

$$\frac{h}{\text{radius}} = \text{versin} = \frac{0.10923}{1.5} = 0.07282 = 22° \quad (23)$$

or

$$1 - \frac{h}{\text{radius}} = \cos = 1 - \frac{0.10923}{1.5} = 0.92718 = 22° \quad (24)$$

$$\text{rad} \times \sin = \tfrac{1}{2} \text{ chord} = 1.5 \times 0.37461 = 0.5619 \quad (25)$$

Chord and height of segment given:

$$\text{dia. of circle} = \frac{\frac{1}{2} \text{ chord}^2}{h} + h = \frac{0.5619^2}{0.10923} + 0.10923 = 3, \text{ nearly.} \quad (26)$$

Principle of Wire Measurement and Some of Its Applications

The general principles which govern the measurement of angular work by means of wires or disks are briefly outlined. It should be distinctly understood that the one-wire method checks the position of the angle in relation to a predetermined point and does not determine the angular magnitude, this being tested by other means. To test the angle and its position simultaneously, two wires must be used in the angular groove and two

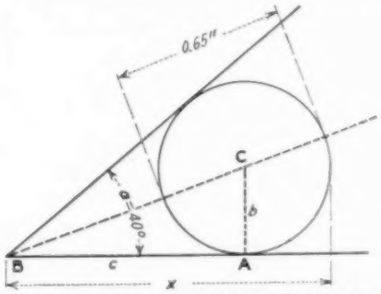


FIG. 9. SIMPLE APPLICATION OF THE WIRE METHOD

wires in conjunction with a sloping side, or two different positions of the same wire adopted.

Figs. 9 and 10 show a simple application of the wire method and how the formula is derived.

A line drawn from point B to the center of the circle bisects the angle α and forms the hypotenuse of the

FIG. 10. APPLICATION OF THE WIRE METHOD TO TWO ANGLES OF EQUAL MAGNITUDE

right triangle BCA. The radius of the circle forms the perpendicular of the triangle, hence from the formulas for solving right-angle triangles (case IV):

$$c = b \times \cot \tfrac{1}{2}\alpha = 0.325 \times \cot 20^\circ = 0.325 \times 2.7475 = 0.8929 \quad (27)$$

By adding 1 to the cotangent of the angle and multiplying by the radius, the distance to the outer edge of the wire is calculated:

$$x = (1 + \cot \tfrac{1}{2}\alpha) \text{ rad} = 3.7475 \times 0.325 = 1.2179 \quad (28)$$

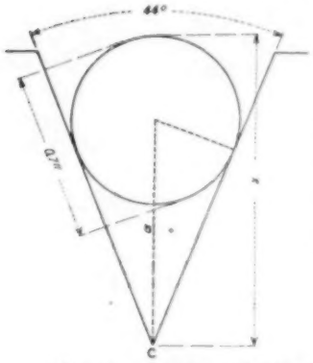


FIG. 11. APPLICATION OF THE WIRE METHOD TO AN ACUTE ANGLE

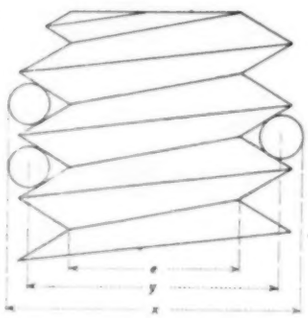


FIG. 12. MEASURING A THREAD BY THE WIRE METHOD

If the work has two angles of equal magnitude, as in Fig. 10, the center to center distance and the overall dimensions are found by doubling the results for one side, or by substituting the diameter for the radius in the previous formulas, which amounts to the same thing.

Hence the center to center distance

$$= (\text{dia} \times \cot \tfrac{1}{2}\alpha) + e = (0.65 \times 2.7475) + 0.8 = 2.58587 \quad (29)$$

The overall distance

$$= e + (1 + \cot \tfrac{1}{2}\alpha) \text{ dia} = 0.8 + (3.7475 \times 0.65) = 3.23587 \quad (30)$$

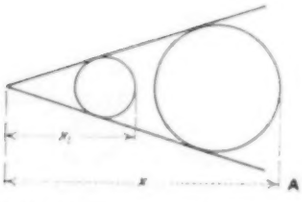


FIG. 13. TESTING THE ANGLE BY THE USE OF TWO WIRES OF DIFFERENT DIAMETERS

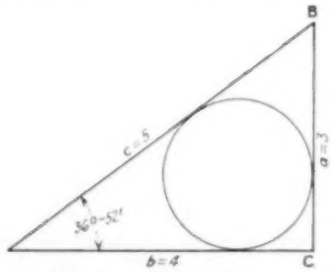


FIG. 14. CIRCLE INSCRIBED IN A RIGHT TRIANGLE

Fig. 11 shows another important application of wire measurement. Reference to the diagram will show that a right triangle is formed which can be solved from the formulas given in case IV.

$$a = \text{rad} \times \text{cosec} \tfrac{1}{2}C = 0.35 \times 2.6695 = 0.9343 \quad (31)$$

By adding 1 to the cosecant of this angle the formula for the overall dimension takes the following form:

$$x = (1 + \text{cosec} \tfrac{1}{2}C) \text{ rad} = 3.6695 \times 0.35'' = 1.2843 \quad (32)$$

Similarly for double angled cases, Fig. 12,

$$y = (\text{dia} \times \text{cosec} \tfrac{1}{2}C) + e \quad (33)$$

$$x = e + (1 + \text{cosec} \tfrac{1}{2}C) \text{ dia} \quad (34)$$

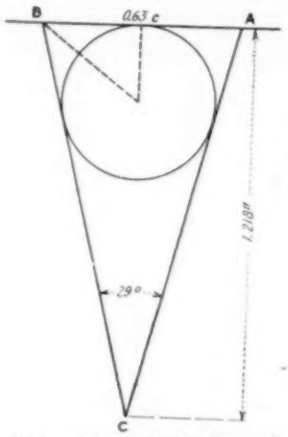


FIG. 15. CIRCLE INSCRIBED IN AN ISOSCELES TRIANGLE

If a test of the angle, Fig. 13, is desired, another wire of larger diameter can be located higher in the groove, using the same formula (No. 32) to obtain the overall dimensions x and x_1. If the second reading of the micrometer corresponds with the figures, then the angle must be correct.

A method of testing the accuracy of an angular space, assuming the angle is correct, is sometimes used when checking tooth gages, screw threads, gages for bevel gear blanks, etc. Formulas to determine the size of the inscribed circle for right and isosceles triangles are given and should be used in conjunction with Figs. 14 and 15.

Circle Inscribed in a Right Triangle

Given an angle and one side (not the hypotenuse),

$$\text{radius} = \frac{\text{side } b}{1 + \cot \frac{1}{2}A} = \frac{4}{4.0003} = 1, \text{ nearly.} \quad (35)$$

Given an angle and the hypotenuse,

$$\text{radius} = \frac{\text{hyp.} \times \cos A}{1 + \cot \frac{1}{2}A} = \frac{5 \times 0.80003}{1 + 3.0003} = 1, \text{ nearly.} \quad (36)$$

Given three sides,

$$\text{dia (of disk)} = a + b - c = 7 - 5 = 2. \quad (37)$$

Given two sides, a and b,

$$\tan A = \frac{a}{b} = \frac{3}{4} = 36^\circ\ 52' \quad (38)$$

and

$$\text{rad.} = \frac{\text{side } b}{1 + \text{cot} \frac{1}{2}A} = \frac{4}{4.0003} = 1, \text{ nearly.} \quad (39)$$

Circle Inscribed in an Isosceles Triangle

Given base c and angle C,

$$\tfrac{1}{2}B = \frac{180 - C}{4} = 37^\circ\ 45'.$$

$$\text{diameter (of disk)} = c \times \tan \tfrac{1}{2}B = 0.63 \times 0.77428 = 0.4878. \quad (40)$$

Given depth and angle C,

$$\text{rad (of disk)} = \frac{\text{depth}}{1 + \text{cosec} \frac{1}{2}C} = \frac{1.218}{4.9939} = 0.2439. \quad (41)$$

The Solution of Oblique Triangles

The following formulas for the solution of oblique triangles are so arranged that no negative quantities can be introduced. In cases III and IV it may be found

necessary to obtain the function of an angle greater than 90, but as the solutions are obtained through the medium of the sine, which is positive for all angles up to 180, no trouble will occur. Hence to obtain the sine of an angle greater than 90, take the given angle from 180 and find the sine of the result.

CASE 1. Given the three sides, Fig. 16.

Let c = the longest side of the given triangle,
b = the shortest side,
a = the third side.

Divide the triangle into two right triangles, with bases e and d. Then

$$d - e = \frac{(a+b)\times(a-b)}{c} = \frac{2.7\times 0.1}{1.5} = \frac{0.27}{1.5} = 0.18 \quad (42)$$

$$d = \frac{c+d-e}{2} = \frac{1.5+0.18}{2} = 0.84 \quad (43)$$

$$e = c - d = 1.5 - 0.84 = 0.66 \quad (44)$$

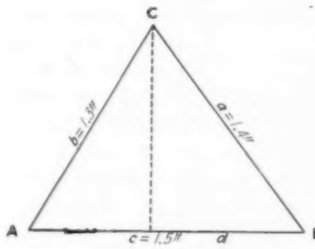


FIG. 16. GIVEN THE THREE SIDES (CASE I)

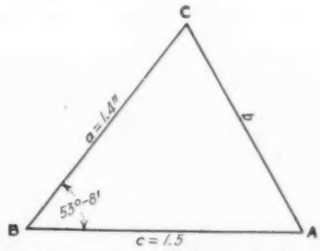


FIG. 17. GIVEN TWO SIDES AND THE INCLUDED ANGLE (CASE II)

Solving for two right triangles,

$$\cos A = \frac{e}{b} = \frac{0.66}{1.3} = 0.50769 = 59^\circ\ 29' \quad (45)$$

$$\cos B = \frac{d}{a} = \frac{0.84}{1.4} = 0.6 = 53^\circ\ 8' \quad (46)$$

$$C = 180^\circ - (A + B) = 180^\circ - 112^\circ\ 37' = 67^\circ\ 23' \quad (47)$$

The above method of solution is simple and the best for general use, but when the sides are very small numbers and a table of squares is available, the following formulas can be used to advantage:

$$\cos A = \frac{b^2 + c^2 - a^2}{2bc}$$

$$\cos B = \frac{a^2 + c^2 - b^2}{2ac}$$

$$C = 180 - (A + B)$$

CASE II. Given two sides and the included angle, Fig. 17.

Call the longer known side c, the other side a, the unknown side b and the opposite angles C, A and B. Then

$$\frac{C+A}{2} = 90 - \frac{B}{2} = 90^\circ - 26^\circ\ 34' = 63^\circ\ 26' \quad (48)$$

$$\tan\frac{C-A}{2} = \frac{c-a}{c+a}\tan\frac{C+A}{2} = \frac{1.5-1.4}{1.5+1.4}\times\tan 63^\circ\ 26'$$

$$= 0.03448 \times 2 = 0.06896 = 3^\circ\ 57' \quad (49)$$

C = sum of (1) and (2) = $67^\circ\ 23'$ (50)

$$A = 180 - (B + C) = 180^\circ - 120^\circ\ 31' = 59^\circ\ 29' \quad (51)$$

$$b = \frac{c\times\sin B}{\sin C} = \frac{1.5\times 0.80003}{0.9231} = 1.3 \quad (52)$$

CASE III. Given two sides and the angle opposite one of the sides, Fig. 18.

Call the known sides b and c, the third side a and the opposite angles B, C and A.

$$\sin C = \frac{c\times\sin B}{b} = \frac{1.5\times 0.80003}{1.3} = 0.9231 = 67^\circ\ 23' \quad (53)$$

$$A = 180 - (B + C) = 180^\circ - 120^\circ\ 31' = 59^\circ\ 29' \quad (54)$$

$$a = \frac{c\times\sin A}{\sin C} = \frac{1.5\times 0.86148}{0.9231} = 1.4, \text{ nearly.} \quad (55)$$

CASE IV. Given one side and two angles, Fig. 19.

Call the known angles A and B, the third angle C and the opposite sides a, b and c.

Then

$$C = 180 - (A + B) = 67^\circ\ 23' \quad (56)$$

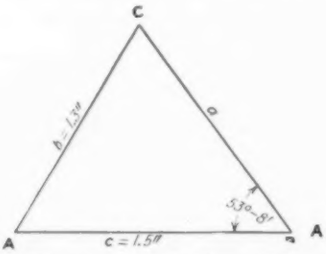


FIG. 18. GIVEN TWO SIDES AND THE ANGLE OPPOSITE ONE OF THE SIDES (CASE III)

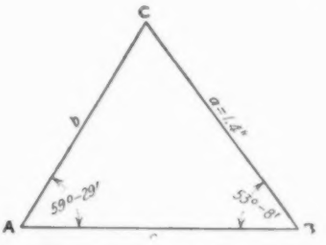


FIG. 19. GIVEN ONE SIDE AND TWO ANGLES (CASE IV)

$$b = \frac{a\times\sin B}{\sin A} = \frac{1.4\times 0.80003}{0.86148} = 1.3 \quad (57)$$

$$c = \frac{a\times\sin C}{\sin A} = \frac{1.4\times 0.9231}{0.86148} = 1.5 \quad (58)$$

Do Things for Employees Who Are Sick

BY FRANK H. WILLIAMS

If there is one time more than another when a person appreciates thoughtfulness on the part of friends, acquaintances and employers, it is when he is ill. During the time that a man is confined to his home or to his bed he is very apt to form a definite opinion as to just who are his friends and who are not. And it is quite possible that he will discover that some of the folks he thought were his best friends fail to call on him or do anything for him.

It is because of this attitude of a sick man toward the world that any kindness shown him during the period of his confinement by his employers will make an everlasting impression upon him.

This being the case, it is interesting to note that the industrial service department of the General Electric Co. at Fort Wayne, Ind., is going out of its way to do things for the employees of the plant who are ill, whether such employees are men or women. One of the good things done by the service department is the distribution of books and magazines among the employees who are laid up. The contributions of books and magazines are secured from well employees and the distribution is supervised by the service department. This plan has met with much appreciation on the part of employees and it is probable that it would work as successfully for other plants.

Boxing Heavy Turret Lathes

By FRED H. COLVIN
Editor, *American Machinist*

ANOTHER contribution to the subject of boxing machinery for long-distance shipment comes through the courtesy of the Gisholt Machine Co., Madison, Wis. This shows how the company solves the problem of boxing heavy turret lathes so as to have its machines reach their destination in good condition and ready to go on the job.

The proper boxing of heavy turret lathes can well be studied, for the principles involved can be applied to a large number of machines of various kinds having similar conditions as to length and weight. The boxing described is that for a Gisholt 24-in. turret lathe, which weighs a little over 7,000 lb., the crate being approximately 11 ft. long, 4 ft. wide and between 5½ and 6 ft. high. In Fig. 1 is shown the machine in the crate, with the men just starting to put on the outside board covering. Fig. 2 shows the crate in outline and gives the dimensions of the various members. The steel tie rods shown are ½ in. in diameter.

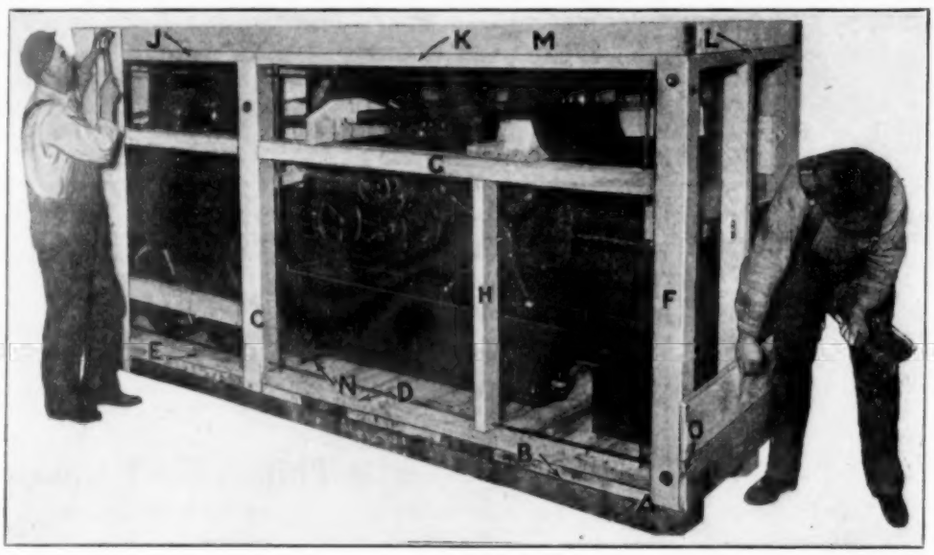


FIG. 1. BOXING A 24-IN. TURRET LATHE

The platform skids *A* in Fig. 1 are 4 x 6 in., one on each side and one in the center. On top of them are the 2 x 10-in. cross-planks *B*, completing the platform. An opening is left in the floor planking for the upright *C*, which is also 4 x 6 in. Then the sills *D* and *E* of 3 x 4-in. lumber are nailed into place and the uprights *H*, corner pieces *F* and side rails *G*, are nailed into place. The side rails are 3 x 4 in. as are the vertical supports *H* and *I*. Other pieces at *J*, *K* and *L* brace the upper ends of the vertical members, after which an upper framework *M*, of 4 x 4-in. stuff is fastened into position.

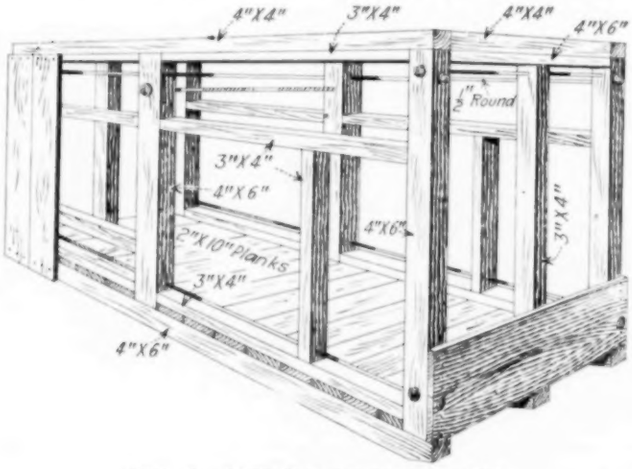


FIG. 2. DETAILS OF THE CRATE

FIG. 3. READY FOR A LONG JOURNEY

A careful study of Fig. 1 will show how the counter-shaft is stowed away over the lathe bed and the way in which the pulleys find a place in the lower left-hand corner. A block *N* holds this point of the bed against side motion, and the location of the ½-in. tie rods are clearly shown.

The outside covering of the box is made of ⅞-in. matched boards 7 in. wide. The way in which these boards are fitted over the nuts on the end of the tie rods is shown at *O*, the end of the board being hollowed out to give room for the nut and still protect it.

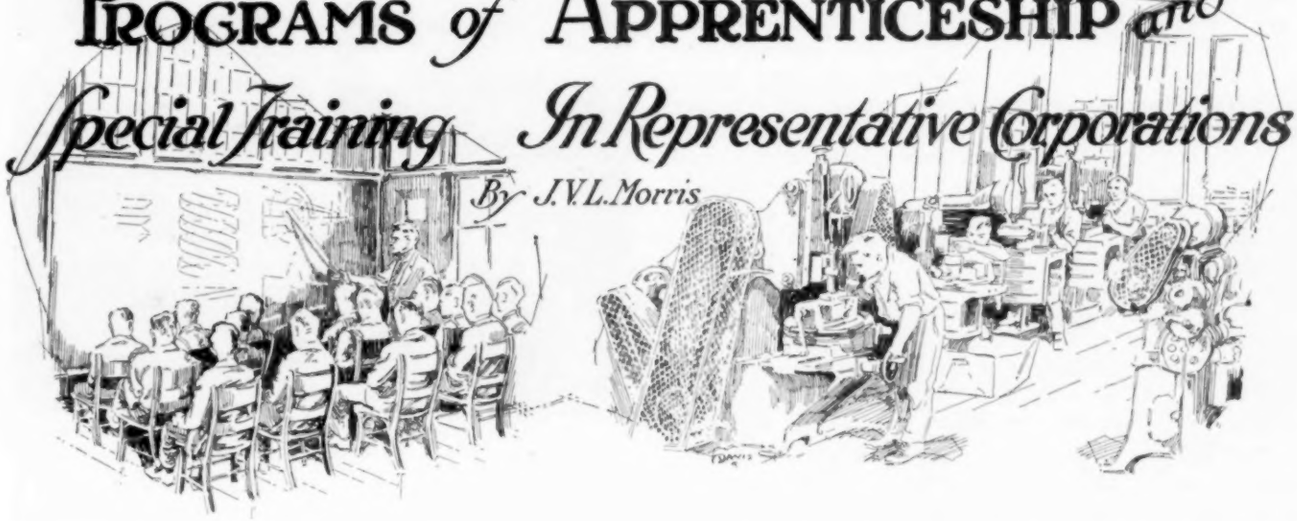
On every box for export a waterproof covering known as "keepdry" is placed over the top of the machine and the top covering boards nailed over it. No metal banding strips are used except on small cases or boxes of parts of machines. The nails used vary from 40 d. to 8 d.—both 20 d. and 16 d. coming in between. These are used as called for by the thickness of lumber.

All machines are well slushed with a compound which will stand 110 deg. of heat. It is important that the slushing compound be carefully put on in order to be sure that all of the polished parts are completely covered. It is not so important that the slush be put on thick, as experience has shown that a thin coat is sometimes better than a thick one on account of the lessened liability of the slush to slip off polished surfaces.

Fig. 3 shows six cases of turret lathes being loaded for export. The gross weight of each is 8,450 pounds.

Programs of Apprenticeship and Special Training In Representative Corporations

By J.V.L. Morris



IN THE plant of the United Shoe Machinery Co. are to be found two distinct types of industrial education and training. On the one hand, there is the Beverly Independent Industrial School, with its special training department provided in the company's plant and now operating in its eleventh year, and on the other, a newly inaugurated intensive training department.

THE CO-OPERATIVE INDUSTRIAL SCHOOL.—Although having its own board of trustees and receiving support in the main from public school funds, the Industrial School is included in this discussion because it functions as the exact counterpart of the corporation apprentice school found in so many plants. The school is conducted on the co-operative half-time principle, one-half of the boys being in the school while the other half is in the training department at the factory. The groups alternate positions each week.

At the present time, there are seventy boys enrolled, thirty-five in each group. The school staff consists of a director, two machinist instructors, a science instructor and a shop foreman. Each machinist instructor devotes all his attention to a single group, accompanying it back and forth as it transfers alternately from school to shop, and he can thus effectively tie up the instruction in the school to the shop problems that arise at the work. The pay given the boy for his twenty-five weeks of shop-work per year is 50 per cent of the standard piece-work price paid regularly in the plant. The remaining 50 per cent is credited to the school fund of the company to defray upkeep and depreciation of the section of the plant turned over to the training department, shown in Fig. 39. Instruction in the school proper, in addition to essential trade training and mathematics, is in applied science, drafting, a class which is shown in Fig. 40, English and citizenship, which subjects have been organized into a teaching program to suit the needs of boys whose interests are primarily industrial. At the start a four-year course was planned, but apparently experience has shown the advisability of transferring to full time at

VIII. The United Shoe Machinery Co., Beverly, Mass.

Here is a system of apprentice training that is a departure from the accepted form, in that the boys attend the school and the shop on alternate weeks. The school work is given in co-operation with the public school system. Intensive training for machine hands is also provided.

(*Part VII was published in the Dec. 23 issue.*)

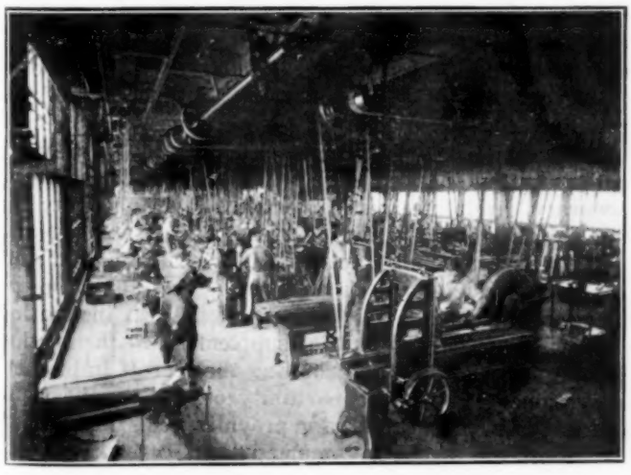


FIG. 39. CLASS "A" IN THE TRAINING DEPARTMENT

FIG. 40. CLASS "B" AT SCHOOL IN A DRAFTING CLASS

the plant those who have attained efficient production, this occurring usually at the completion of the second year. Owing, however, to state laws relative to the operation of power machinery by minors, graduation to journeyman's grade never takes place until the age of eighteen is reached, no matter how capable the boy may have become.

In the last report published, that for the tenth school year ending in July, 1919, when the war may have still somewhat adversely disturbed conditions by making extraordinary demands for labor, the enrollment according to ages was as follows:

14 to 15 years of age	0
15 " 16 " " "	38
16 " 17 " " "	37
17 " 18 " " "	12
18 " 21 " " "	11
21 " 25 " " "	2
Total for year	100
Average for year	53

The half earnings for the year 1919 were $4,614.47, with a rate per hour paid to the pupil of 11.2 cents, the actual rate earned being 22.4 cents. Dividing the half earnings by the average enrollment for this period (53), we find that the average yearly earnings of each student were $87.06. It should also be noted that, whereas twelve were promoted to full time by completing the course, twenty resigned to enter upon regular production with the course uncompleted, thus suggesting that the institution was being utilized as a kind of vestibule school. Altogether, from the opening of the school on Aug. 2, 1909, to July 20, 1919, the graduates have numbered one hundred, all being in the machinists' trade. It is stated that the last seventeen promoted to full time in the factory, such boys during their first year being transferred about the plant so as to give them general experience, started with a rating of 55

FIG. 41. ON PRODUCTION WORK AFTER GRADUATION FROM THE CO-OPERATIVE INDUSTRIAL SCHOOL

cents an hour. A boy is shown in Fig. 41 working at production in the shop after his graduation from the Industrial School.

INTENSIVE TRAINING.—The intensive training department is newly inaugurated, and to some extent is still in an experimental state. It has a corps of four instructors selected from among the best foremen in the plant

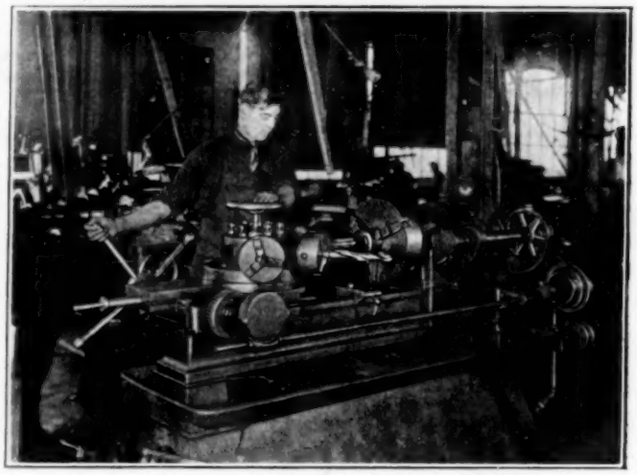


FIG. 42. A RECRUIT UNDER INTENSIVE TRAINING

and a superintendent with a long practical and theoretical experience. The following equipment was being used to capacity to train recruits at the time that this investigation was made: 14 horizontal milling machines, 3 vertical milling machines, 10 four-spindle and single-spindle upright drilling machines, 12 lathes and 2 plain grinding machines. Besides the forty-one men thus provided with machines, the operation of which they were learning, there were twelve additional men receiving bench instruction, making fifty-three in all. In Fig. 42 is shown a view in the intensive training department.

The ordinary period of training is three months, though this is naturally subject to adjustment, as obviously the most skillful would be promoted to regular production whenever a vacancy occurred irrespective of the length of training period. Pay in this department is fixed at fifty cents an hour irrespective of amount of production, and it was stated that those transferred to regular production on a piece-work basis were having no difficulty in maintaining a rate in excess of the minimum fixed for the plant.

ORAL TOPICS

In the main, the instruction is confined to developing the skill necessary to successfully operate the one machine or to perform the bench operations being taught in each case. Supplementary to this, however, either individually or in small groups the superintendent gives oral instruction on the following topics: (1) Plant layout, (2) department location, (3) object of the department and the results expected, (4) company expenses on equipment and maintenance, (5) brief outline of methods of transportation, (6) methods of accounting for work charged to department, (7) brief outline of methods of tooling, (8) application of drawing and operation sheet to work, (9) necessity for interest, accuracy, discipline, and self reliance, (10) necessity for quality first and quantity later, (11) explanation and application of simple tools, such as scale, micrometer, etc., (12) scale and decimal equivalents, (13) hospital, location and purpose, (14) find out natural inclination of new employee. This brief supplementary instruction should materially aid in orienting the recruit in his new environment, and the opportunity offered by the separate training department for providing this instruction is one of the strong recommendations for such a provision.

The Application of Babbitt Metals

Practical Suggestions on Grooving, Alignment, Anchorage and Shrinkage—Results of Casting the Metal When It Is Overheated

By L. D. STAPLIN
Manager Merit Metal Department, Great Western Smelting and Refining Co.

MANY users of babbitt metal feel that it is only necessary to procure a good grade of metal and their bearing troubles will be over. This result does not always follow, as good metal, carelessly applied, means eventual trouble in most cases. For that reason the progressive consumer should make sure that his bearings are made slowly and with careful attention to detail. Because of their added service value, bearings made in this way will return the extra cost of this thoroughness many-fold.

In service, trouble is often occasioned by faulty alignment and grooving. In view of all that has been written on the subject, it seems strange that such should be the case, but it merely proves that bearing makers, as a rule, do not sufficiently realize the importance of these factors and sacrifice durability through lack of attention to them.

How To Do Good Grooving

The rules for good grooving are simple. Groove as little as possible and yet enough to distribute the lubricant evenly on the bearing's surface and particularly on that portion of the surface carrying the load, since an excess of grooving in the latter increases the pressure per unit of contact area.

All grooves should have rounded edges. Experience has taught the writer to look first for sharp corners on the grooves when trying to diagnose bearing trouble. A sharp edge left on a groove, as in Fig. 2, acts as a scraper and destroys the oil film. Round the edges as shown in Fig. 3, and the value of the lubricant is increased and the friction reduced.

When it is necessary to groove the load-carrying part of a two-part bearing, the following method has been found effective: with a boring tool or milling cutter remove the material from both edges of both halves of the bearing except for about half an inch at each end, as shown in Fig. 1, thus making an oil chamber about $\frac{1}{2}$ in. wide and $\frac{1}{8}$ in. deep on each side, then, at each end of the lower part only, cut a narrow groove parallel to the ends, connecting the two lengthwise recesses.

Alignment of Bearings

With sufficient patience any average mechanic can align a bearing correctly. It is only a question of willingness to take the necessary time to do a job in which it pays to be thorough. It is not enough to secure proper alignment when the bearing is made and then feel that the job is done. Before the bearing has run too long it should be examined, for in almost all cases readjustment will be found necessary because of unequal wear. If good alignment can be held, the best babbitt metal should be used on important heavy-pressure, high-speed bearings. If not, it is important to use an alloy adapted to the special conditions, having a plastic and yielding body, which will better conform to the contact surface.

Not many years ago the sale of the logging engines made by the largest iron works upon the Northwest Coast was hampered because the crankpin bearings became loose. Almost every known make of good babbitt metal was tried in an effort to find an alloy that would hold the bearings. The fault was so common that loggers objected to buying the engines. By request the writer followed two of the engines into the woods. When Sunday came, the crankpin brasses needed lining. Examination showed the simple fact that the anchors were too shallow to hold, because in service a logging

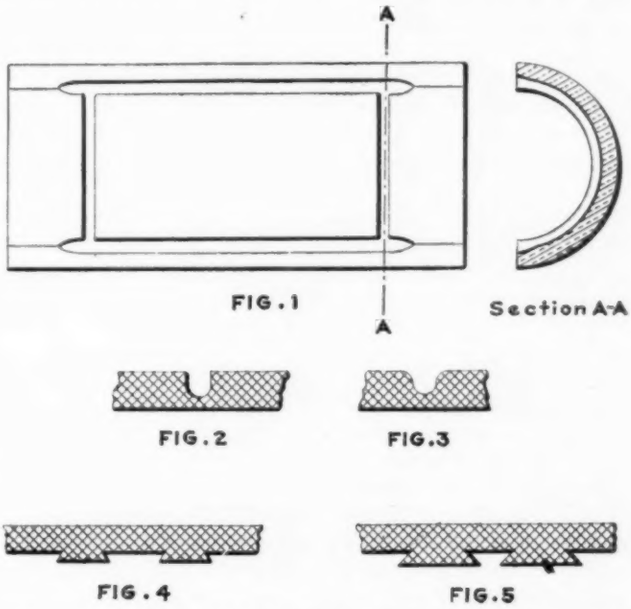


FIG. 1. GROOVING IN LOWER HALF OF TWO-PART BEARING. FIG. 2. GROOVE WITH SHARP EDGES, BAD. FIG. 3. GROOVE WITH ROUNDED EDGES, GOOD. FIG. 4. SHALLOW AND WEAK ANCHORAGE. FIG. 5. GOOD SOLID ANCHORAGE

engine crankpin brass is subject to extreme vibration. By making the anchorage deeper and using a little different style of anchor (see Figs. 4 and 5) the trouble was entirely remedied. The incident shows how simple seemingly serious bearing troubles frequently are. When trying to remedy loose liners, it will pay to examine the anchorage first.

If the service is at all severe, there should be close contact between the container and the liner. Even though the anchorage is right, experience may prove that soldering or tinning is desirable, and this can be done in the following manner, using a solder of 50 per cent tin and 50 per cent lead.

For tinning brass shells the first step is the removal of grease, dirt and other foreign matter from the shells by heating them, being careful not to overheat the material of the shell or the subsequent tinning will be difficult. A good way to remove oxide scale and to produce a good clean surface is to "pickle" the

shells in a bath of water four parts and muriatic acid one part. In obstinate cases the most satisfactory way of preparing the shell for tinning is to machine or grind the surface to insure a clean metallic contact.

After cleaning, the surface is treated with zinc-chloride soldering solution and warmed either by plunging the shell into a quantity of melted babbitt metal or placing it over a fire. In the former case, a portion will adhere to the prepared face and can be spread over the surface later with a small brush, producing a mirror-like coating. In addition to this the hot face of the shell should be rubbed with a stick of solder and then brushed. This will give a good coating of solder on the prepared surface. If the shell is too hot, it will not take the solder well.

Tinning of steel shells may be accomplished in practically the same way, but care must be used in making the surface to be tinned perfectly clean and free from oil of any kind. Tinning of cast-iron shells is difficult ordinarily, but if sufficient care is taken to file the surface bright just before applying the solder, a good coating may be caused to adhere.

How to Prevent Shrinkage

Metals expand on heating and contract on cooling. There is shrinkage in every bearing metal. The hotter the metal when poured the more it expands and the more likely it is to make a lining that may not adhere solid and tight to the backing. This is because of the shrinkage in the metal when it solidifies, which may be sufficient to cause it to pull away from the backing, leaving a space into which the metal can be pressed beneath the load, thus possibly cracking the lining metal and causing it to break.

The commonly given instruction, "Heat mandrel and container whenever possible before casting," is the cause of more poor bearings than any other one common casting direction. It does not make so much difference if a low-grade bearing metal is cast while it is overheated, as its high content of lead prevents much change in structure during the cooling; but if a babbitt metal of the highest grade, such as carries a tin base and considerable content of copper, is cast while overheated, the service value of the metal will be greatly reduced. A good rule to follow where durability is desired, is to cast the metal at the lowest heat at which it will be fluid enough to flow into the bearing at one pour, and against surfaces that have been warmed only enough to remove the chill. If the container or mandrel sizzles when touched with a moistened finger, it is too hot. The more dense and solid the metal's structure, the greater will be its durability, and the foregoing principle, if applied (see Fig. 6), will produce bearings of the best value in density.

To Increase Density

It is desirable to increase the density when casting removable bearings, which may be done by immersing them in cold water as soon as the metal has solidified after casting. In doing this always be careful to immerse the casting from the bottom upward and do it slowly. The spot at which the metal is poured is always the hottest part of the casting and in cooling should enter the water last. This sudden cooling will close up the grain so that under the pressure and load of service it will not "pack" or "give."

Overheating will open the grain or coarsen the structure of babbitt metal. Since "grain" only means the distance between the particles that comprise the metal's structure, it follows that beneath sufficient pressure these particles will be packed together by the weight of the load upon the metal. This makes "clearance" equivalent to the same amount of wear.

This "packing" can be avoided if the metal is dense and solid, as it will be in ratio to its temperature when poured. Necessarily, the babbitt must be made hotter for a large than for a small casting, so heat according to the work in hand and do not be afraid to spoil a couple of castings in learning the lowest heat point. Experimentation in this connection will be repaid many-fold in the time saved in rebabbitting.

A Typical Case of Overheating Trouble

To illustrate a typical case of trouble caused by overheating a high-grade babbitt metal, the following experience will serve: The writer was called to the mill of a sugar manufacturer having trouble with centrifugal bearings. Examination showed that some

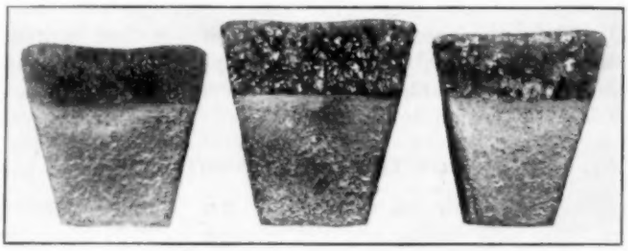


FIG. 6. STRUCTURE OF BABBITT METAL WHEN CAST AT PROPER TEMPERATURE, WHEN SLIGHTLY OVERHEATED AND WHEN GREATLY OVERHEATED

would run a full season and others in the same type of machine and made from the same metal would last only a few days. After running a few days, the metal started to slough out of the bearing. By examining one of these bearings with a glass, the metal was found to contain minute cracks which would enlarge and finally cause the metal to give way under the vibration of service. The cracks were caused by contraction of the metal while cooling, after overheating and casting against a mandrel that was too warm.

If a lead-based, moderate-priced babbitt such as is so widely used for general work is poured when overheated or against an overheated mandrel, the results, as previously explained, are not so serious. Babbitts of this class are not likely to be "ladle spoiled," and to this good point they owe considerable of their popularity. However, overheating will make them brittle and more likely to break, crack or crumble beneath heavy loads and high speeds.

A steel company was testing a certain alloy in its rolls. Two bearings were cast with the metal nearly red when poured. At the end of five days the liner was $\frac{3}{32}$ in. thinner than when the test started. It had packed that much beneath the load. The two bearings were then cast at the proper temperature, and after running for twelve days they were tested and found within a trifle less than $\frac{1}{32}$ in. of their original thickness. It was customary to reline these bearings when the liners had worn to a certain thickness; hence, by casting the metal with care, the company was able to put more tonnage through the rolls that were correctly babbitted, with a saving of time, money and annoyance.

Railroad Blacksmith Machine Equipment

Describing a Small but Interesting Collection of Machines and Tools for Expediting the Work of the Railroad Blacksmith

By J. V. HUNTER
Western Editor, *American Machinist*

A SMALL but interesting collection of machines and tools for expediting the work of the blacksmith is found in the Decatur car shops of the Wabash Railway Co. Here the foreman, H. A. Vahe, has devoted considerable time to analyzing many of the working problems of his men and has devised a number of tools to make their duties less arduous.

Heading the 1¼-in. rivets of draw-bar couplers has been a heavy job to handle with a hammer and so this work is now done by the riveting device shown in Fig. 1. The reader can judge from a study of the double combination of toggle-arms the great power of this riveting press. The power unit is a 16-in. standard air-brake cylinder mounted on one end of a base constructed of steel shapes. The channel and old rails used in this base are actually of insufficient strength for the pressure that is exerted and care must be used that too much pressure is not applied. The heading die is mounted on the end of the plunger sliding through the guide head *A*, Fig. 1. The operation is controlled by a three-way air valve at *B*.

A small portable bending machine is shown in Fig. 2. It has the advantage that it may be pulled from one fire to another when the work of different blacksmiths necessitates their using this device. A 10-in. air cylinder furnishes the pressure and the small dies used are bolted direct to an attachment block on the end of the piston rod. When the illustration was made the machine was set up for bending a number of U-bolts, and the stop-bar *A* for gaging the length of these is seen extending to the right.

A device which employs a heavy pneumatic riveting hammer for cold-heading the button-heads on a ½-in. bar used in a freight car step is shown in Fig. 3. The device is built on a piece of 6-in. channel, mounted vertically in a concrete base. The foot lever *A* at the left, through a combination of levers, operates a pair of clamping jaws at *B* that grip and hold the round bar in place while the cold heading is being done. The foot lever at the right serves to bring the hammer down to the work and holds it in place while the riveting is being done. Air is admitted to the hammer by a trigger on the hammer handle. It will be noted that the hammer is counterweighted by the lever *C*, extending to the rear, so that it automatically raises the hammer to clear the work when the foot-pressure is released. The press shown in Fig. 4 is used for straightening all manner of angles, channels and bent steel parts from cars that come in for repairs. It is a very powerful unit, driven by a 16-x 12-in. air cylinder mounted at *A*. Motion from the piston is transmitted to the ram through the lever B. As originally designed it was

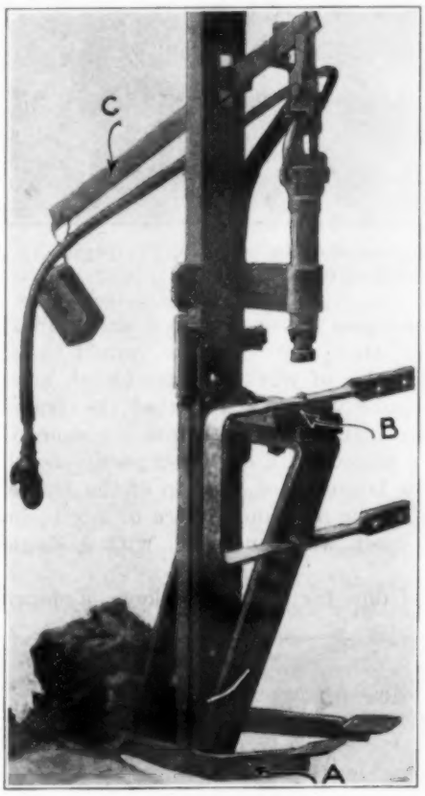


FIG. 3. RIVETING DEVICE FOR COLD HEADING BARS IN CAR STEPS

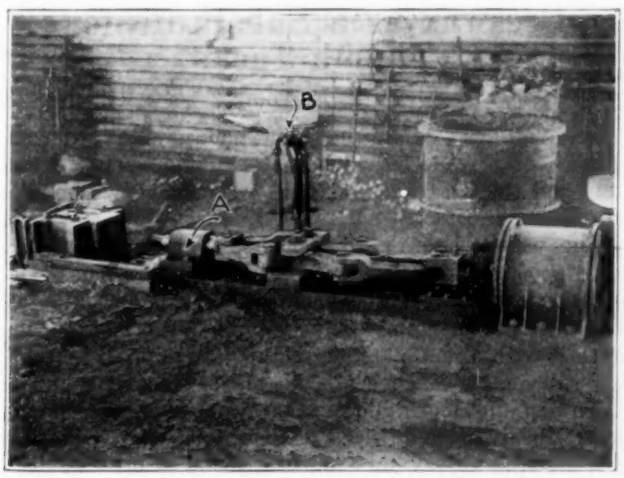


FIG. 1. HEADING DEVICE FOR COUPLER YOKE RIVETS

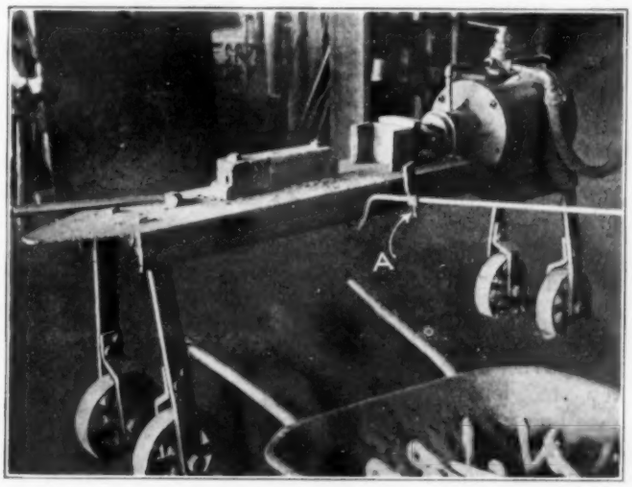


FIG. 2. PORTABLE BENDING MACHINE FOR GENERAL SHOP USE

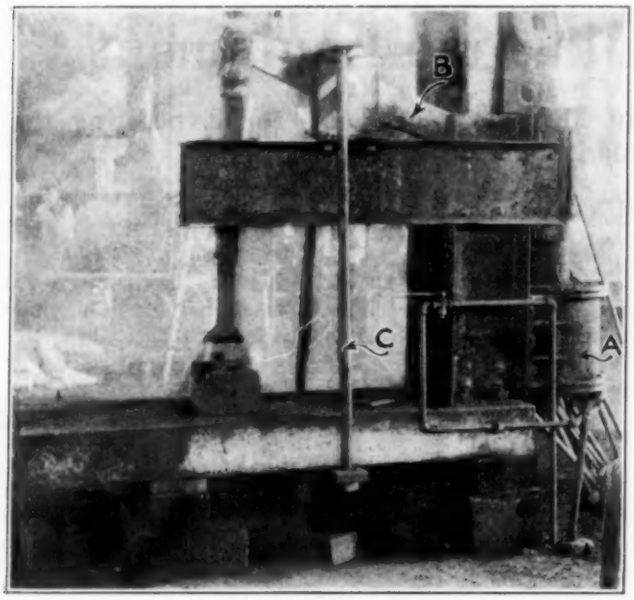


FIG. 4. AIR OPERATED PRESS FOR STRAIGHTENING BENT STEEL SHAPES

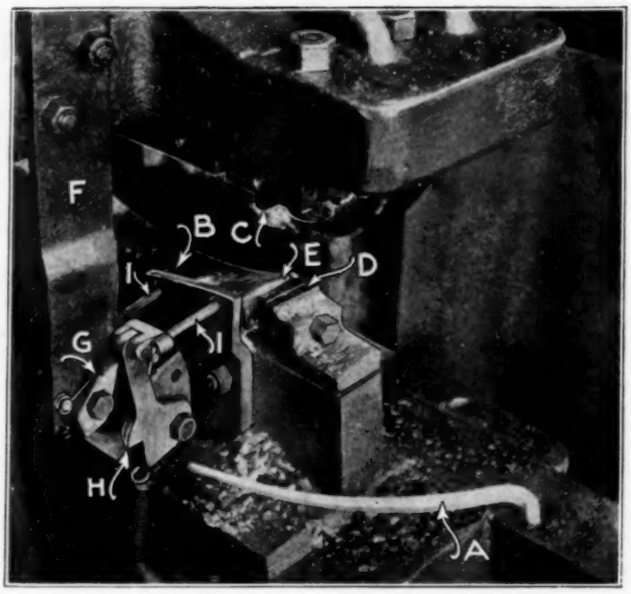


FIG. 5. BRAKE-SHOE KEY-FORMING DIES WITH AUTOMATIC KNOCK-OUT

planned to have the upper channel form a deep throat for the frame so that the machine would have greater range in the size of work. It was found, however, that the pressure was so great that the frame would not stand the thrust, and therefore a couple of tension rods *C* were placed, with bars that pass beneath the bed and over the trunnion on the top of the frame. To show the power of the machine a piece of ¾ x 1¾-in. bar lying in the V-block was bent, cold, with a single thrust of the ram.

An unusual set of dies for brake-shoe keys is shown in the die-head of the brake-shoe forging machine, Fig. 5. After the piece has been tapered the dies form the key shown at *A* in one stroke, including bending the curved portion, trimming to length and kinking the little hook at the top. The forming is done in the section of the die *B* and the latter two operations are performed by the upper blade *C*, which, after trimming the key to length against the lower shear blade *D*, continues its stroke and bends the right-angle kink over the corner of the die *E*. An automatic kick-out is provided to throw the key out of the die on the up-stroke of the die-head. In making its downward stroke the bar *F* carries the trigger finger *G* beneath the hook of the trip *H*. When it goes up this swings the kick-out toward the right so that the bars *I* knock the formed key out of the die.

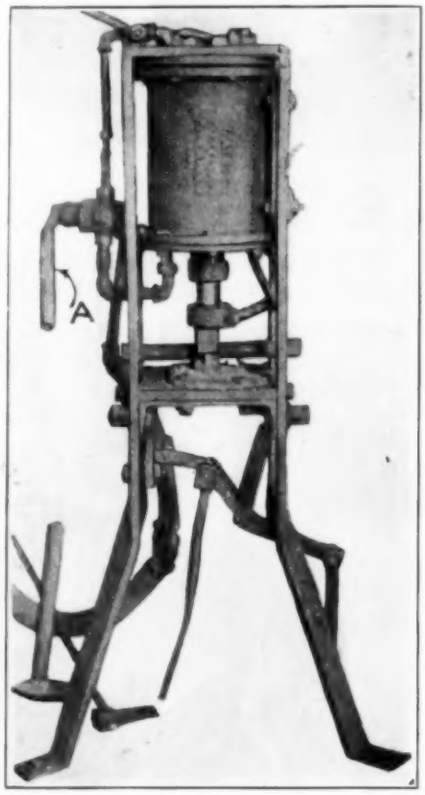


FIG. 6. PRESS FOR HOT-PUNCHING SMALL HOLES

The air-operated punch shown in Fig. 6 is used for hot-punching holes in flat bars or braces. The wreck of what was once intended to be a foot-lever for operating tht air valve still lies beneath the frame and has now been replaced by a hand-lever *A* on the 3-way valve. The frame is constructed with noticeable simplicity as only two long flat bars form both the four legs and the loops over the head of the cylinder. The bed for the die is a short section of channel bolted at its four corners to the frame. The standard plunger end of the air-brake cylinder has been replaced by a head with a packing gland for the piston. This change permits the application of air to the lower end of the cylinder so that power can be developed on the return stroke for stripping the work from the punch.

Beeswax as a Substitute for Thumb Tacks

BY B. E. TOOLE

Did you ever wish that you had a substitute for thumb tacks, especially when working on small drawings and the drafting machine or T-square was bound to ride on the tacks?

The writer had this experience and tried beeswax with good results. The wax was rubbed on the drawing board where the corners of the paper would fall and then the paper laid over it. The corners were then rubbed with a flexible steel scale (a finger nail will do) and sufficient heat generated to soften the wax.

This method of holding paper is extremely handy when the draftsman gets a rush job to do. Instead of removing a drawing from the board to prevent making holes in it by tacking the rush job on top, beeswax may be used.

Early History of Metal Presses*

Probable First "Invention" of Sheet Metal and Press—Description of the Beginning and Growth of the Bliss Company

THE use of sheet metal is quite as eminently respectable in point of great age as is the copper industry recently described to you by Mr. Church. In fact, the origin of the two are co-incident and inter-dependent. The Stone Age furnished the first dies and punches—sharp-edged rocks for cutting or shearing, a hollow in some big boulder combined with a smaller, rounded stone nearly fitting it, were the ancient simple prototypes of our present-day complex cutting and drawing dies and punches. Thus, prior to the discovery of metal, the principles of the tools for working it were at hand.

Oberlin Smith, in his book on "Press Working of Metals" says: "The first man who chanced to dig up a little nugget of native gold or copper, or some other man who found a piece of malleable metal in the ashes of his fire as a result of the accidental smelting of certain ore happening therein, may very probably have pounded it out thinner between two stones, and thus have become the first sheet-metal manufacturer." In this way was probably first produced the material upon which the pressed-metal industry operates. To continue Oberlin Smith's interesting description, "If he then cut it in two by lapping it over the edge of a stone and sliding another down past it, he had invented the first shearing press. If he pushed the end of a sharp-edged cylindrical stone through it into a hole in a stone underneath, he was doing the first punching. If the upper tool was rounded off so as not to cut through, being perhaps a hard-wood stick, he was making a little cup by the process of forming or stamping."

Slow Development of Processes

Naturally, weapons and hollow vessels were the initial wants supplied by this new means. Decades and centuries probably passed in countless primitive experiments involving the acquirement of knowledge of the characteristics of various metals and ways of handling them. If the press operator of today, who tears his hair over the refractory behavior of some particular lot of sheets or the persistance of a set of dies in failing to recognize their plain duty, could but realize that he usually solves in a few minutes or hours problems akin to those that have taken ages to bring to success, he would probably be a little less impatient.

From weapons it was but a step to defensive armor, and here the art of the sheet-metal worker reached a high development. It may be remarked here that in the World War, the pressed-metal industry far more than paralleled the work of the ancient armorer. The steel helmets some of you may have worn were the modern equivalent of the helmets on which Bertrand du Guesquelin and his many famous peers received the cuts and thrusts in which they delighted. Indeed, it was even seriously considered whether breast and back plates might not be added to our war-making equipment. Had this been done we would have seen hundreds of huge machines in the pressed-metal centers of the country, each producing at a single, quiet stroke some piece of armor, to make which in the ancient days would have absorbed many hours, if not days, of the armorer's time. It is well that our defensive armor went no further than helmets. We had enough to do as things were.

Conditions in 19th Century

At the time of the beginning of our concern as Bliss & Mays in 1867, the principles of sheet-metal working were the same as in the middle ages, and comparatively little progress had been made in the details of the tools and machines used. Silversmiths and coppersmiths, as well as the classical village blacksmith, still hammered, punched or drew metal with the aid of tools or implements, improved to be sure, but no great step in advance of the primitive. Horns or forms in vise or anvil had supplanted the lower or larger rock, but, to a large extent the mobile tool was still held by hand.

Metal was "coaxed" more by those early craftsmen than it is today. The limits of drawing or bending, established by experiment and long practice, by which the engineer of today can almost instantly determine the number and extent of steps necessary to achieve a given form, were not then so fully understood as now and the wearying and discouraging "cut and try" method prevailed to a considerable extent.

To give you a picture of the early efforts in drawing metal, we quote here from a letter from the managing director of an old-established metalware concern, describing its initial step (about 1861) in the transition from "pieced ware" to what was then called "French ware"—nothing more than our present seamless or drawn utensils.

"Mr. Tripp (admirably named he was to supervise drop presses) was in charge of the factory. . . . I have often heard him tell of the excitement that was created locally when the first stamped dairy pan was produced and the triumph it was considered.

"There was no engine, the power being furnished by two men who stood behind the drop press and by means of a rope running over a pulley successively lifted the punch or "force" and let it fall upon the sheet of tin plate interposed over the die.

"This crude system proceeded by repeated dropping of the force and the substituting of new forces which extended further into the die than the previous one until the metal was finally coaxed into the shape of a milk pan.

"Afterward a horse was substituted for men to lift the force. Later a steam engine was installed, the buildings extended, new ones erected . . . and a line of stamped, pieced and japanned tinware of creditable proportions for those days was created."

This firm, then Sidney Shepard & Co., had been established in Buffalo some time before ours, in 1836, but prior to the later date previously mentioned, produced only such tinware as could be made by hand—that is, it was made in pieces and seamed and soldered together. The word picture of a notable event in its

*From a paper read before the Brooklyn Engineers' Club, Nov. 18, 1920, by O. P. Hatton, Advertising manager, E. W. Bliss Co., Brooklyn, N. Y.

history gives a very clear idea of the crude, experimental methods then universal.

There were, of course, other simple forms of presses besides drop hammers, which combined the two primitive die members and substituted mechanical means for moving and guiding one of them.

Progress in the pressed-metal industry has been increasingly rapid, as the capacity of sheet metal to stand being squeezed, pressed, drawn, folded and cut into complicated shapes became more fully realized, and as the limits of size and thickness of the metal handled were widened.

The Use of Wood in Freight-Car Construction*

Comparison of Merits of Wood and Steel for Use in Freight-Car Construction—Use of Graded Lumber and Importance of Well-Seasoned Wood

By H. S. SACKETT
Assistant Purchasing Agent, Chicago, Milwaukee and St. Paul Railway Co.

THE fact that over two billion feet of lumber and timber are used annually in the United States for the maintenance of freight equipment and for the construction of new cars, representing an annual outlay for material alone of $50,000,000, is ample evidence of the importance of wood in this big industry.

The first freight cars used for railroad transportation in this country were built of wood and this great natural resource has been an important factor in their construction ever since. In recent years steel has competed with wood, especially in the construction of gondola and other types of open-top cars, but whether this change has been an economical one or not remains a question.

From recent studies made of the subject by disinterested commissions, the indications are that even for open-top cars, wood is still the most economical material. With the growing scarcity of timber, however, and the apparently unlimited supply of steel available, it is probable that this latter material will always be a prominent factor in the construction of cars, and especially so, if some agent is found to reduce materially the present high rate of loss from rust and corrosion.

In the construction of the first cars wood was almost universally used for all parts, except of course the running gear. Within the past decade, however, with the introduction of heavy motive power which spells long and heavy trains, it has been found that wood is no longer capable of withstanding the heavy shocks incident to such operation, and it is generally conceded by all car builders that the freight car of the future must be of steel underframe and steel draft rigging.

This limits the use of wood to unimportant parts of the underframe, such as intermediate sills and crossbeams, and to the superstructure of the car. In the case of open-top cars this means only posts and side and end plank and decking, but in box, stock, and furniture cars, etc., it means siding, lining and roofing.

To take up the question of open-top cars first, statistics gathered by operating officials of some of the larger railway systems seem to indicate that the cost of maintaining steel gondola cars over a period of years is greater than for composite (wooden and steel) cars of the same type. The data[1] collected show that all-steel gondola cars in their twelfth year of service cost over 36 per cent more to maintain than did the composite gondola. Of course, it is probable that during the first five years of its life the steel gondola cost less to maintain, but it is felt that taking the entire twelve years as an average, the cost would be more for the maintenance of the steel than the composite gondola.

It is furthermore interesting to note that but 60 per cent of the composite gondolas in service required repairs, while 72 per cent of the steel gondolas were obliged to be brought to the shops. The actual time that a car is in service and earning money for the road is an important consideration in determining its general utility. It is also interesting to note the conclusions in favor of the composite gondola, which are as follows:

The initial cost of the composite gondola with the present price of steel is less than the all-steel gondola.

The composite type of car costs less to maintain than the steel gondola.

The sides of the composite car do not bulge as do those of the steel car.

The records show that while the composite car costs more to repaint than the steel car, it does not require painting as frequently.

A large portion of the repairs to composite cars can be taken care of at other than steel-car shops.

Certain properties in coal cause corrosion to steel, and wood is not affected by them.

The table shows the annual cost of repairing freight cars since 1908. It will be noted from this table that the cost of repairs per car has increased from $59.30 in 1908 to $80.30 in 1914, an advance of over 35 per cent. This higher cost is due, of course, to a number of factors, but it is felt that no small part of it is due to the use of steel, which requires a greater outlay for material and a higher cost to repair, owing to the fact that it takes longer to make like repairs on a steel car than on a wooden one. It must also be borne in mind that this higher cost is very largely due to the much rougher usage to which freight equipment is now subjected. In recent years the freight business of the railroads has grown enormously, and has necessitated the construction of gravity yards for switching, and the use of fewer switchmen per car handled than in former years. This

ANNUAL COST OF REPAIRING FREIGHT CARS

Year	Number of Freight Cars	Cost of Repairs per Car	Ton-Miles per $1 Repair Cost	1,000 Ton-Miles per Freight Car
1908	2,089,302	$59.30	1,762	104.5
1909	2,073,606	59.70	1,768	105.5
1910	2,135,121	65.60	1,821	119.5
1911	2,117,644	65.10	1,815	117.9
1912	2,140,687	65.50	1,858	121.5
1913	2,209,533	74.70	1,802	134.6
1914	2,263,015	80.30	1,565	125.8

*Presented at the annual meeting, New York, December, 1920, of The American Society of Mechanical Engineers.

[1]Paper by William Queenan, Assistant Superintendent of Shops, C. B. & Q. R.R.

has resulted in severe handling of freight equipment, and is probably responsible to a greater degree than any other factor for the increased cost of repairs in recent years.

In the case of closed-top cars, such as for example stock, box, and furniture cars, there is but little doubt that under present railroading conditions the understructure should be of steel with a wooden superstructure. The steel understructure is required to withstand the shocks of service and to give rigidity and stability to the car, while the wood is desired to give lightness and general utility to the body. Some all-steel box cars are in use today, but their heaviness and the fact that nails and cleats cannot be used in them to brace and hold the lading, are strong factors against the use of this material. It has not met with favor with shippers generally and probably will not as long as wood continues to remain available. No material has yet been discovered which combines the properties of strength, lightness, availability, and ease of working such as is possessed by wood, and until such a material is developed and made available, wood will undoubtedly continue to be universally used for the superstructure of freight cars.

The dead weight of cars is also an important factor in considering the cost of and earnings from freight haul. There is no doubt but what the excessive weight of the all-steel car has been one of the most deterrent factors to its general adoption in freight-car construction, and this fact together with its lack of readily available repair parts and the large expenditure required to equip shops to efficiently handle all-steel equipment, have combined to retard and limit its use.

Graded Lumber in Car Construction

It seems pertinent to say a word at this time as to the grades of material required for the different parts of the body of the car. In the early days when the supply of wood in this country was thought to be inexhaustible, clear grades of wood were generally demanded by the car builders, and in the construction of new cars this is generally the practice at the present time, especially for car roofing and siding—sound-knotted stock being used for decking and lining. Some of the more progressive railroads, however, have gone a step further in recent years and many are now using sound-knotted stock for siding and roofing for repair and maintenance work.

There is no doubt but what such a practice is economical and based on sound judgment, for certainly there is no necessity for using clear material for the repair of many classes of freight equipment, the life of which may not be in excess of seven to ten years. One large railway system which not only constructs its own cars but does repairing on a large scale, has adopted the following practice as to grades:

FOR NEW CARS

Siding	No. 2 Clear and Better Fir
Roofing (double board roof)	No. 2 Clear and Better and Select Common Fir
Roofing (metal-covered)	Select Common Fir
Lining	Select Common Fir
Decking	Select Common Fir

FOR REPAIR WORK

Siding	No. 3 Clear and Select Common Fir
Roofing	Select Common Fir
Lining	No. 1 Common Fir
Decking	No. 1 Common Fir

On this particular railroad the saving on this amended practice amounts to over $500,000 per year, and its economy is apparent.

As far as specifications for end sills, door and side posts, belt rails, etc., are concerned, practice varies widely among the various railroads. Some still insist on oak for such purposes and others have gone to fir and pine. With the rigid steel underframe it is believed the use of soft woods is more justified than ever for posts and belt rail, but unless well protected with steel plates it is believed the use of oak sills is still to be recommended. Oak and other hard woods are becoming more scarce and higher in price each year and it is felt that the general practice very shortly will be pine or fir end sills properly reinforced with steel.

An important feature of car construction which is decidedly in wood's favor, is its general ease of working and adaptability to repair, and this is brought about not only from its qualities which make it easy to cut, saw and shape, but also by its almost universal availability. We have been a wood-using nation for over a century, and artisans familiar with its properties and able to work it are always at hand.

It is also rather curious that the salvage value of wooden cars is greater than that of steel cars, and no one doubts this who has seen the two types of cars in a seriously wrecked condition. The wooden car may be quickly and easily repaired, while the steel car is only rehabilitated at a high cost, or for the most part is fit for the junk pile.

The Importance of Well-Seasoned Wood

Before using wood in the building of freight cars it is vitally important that it be well seasoned. When our grandfathers built a house they expected it to last a century, and it usually did, for they took great care to properly season the wood before putting it to use. In the houses nowadays, however, we use wood almost before it is dry from the saw, and the result is that our American frame houses today are old at fifteen or twenty years and we do not get anywhere near the service out of the wood that we should. Too often today we also see freight cars built of green lumber and timber, with the result that within a few months the bolts are loose, the wood having shrunk away from the original fastenings. This causes rapid deterioration and large timbers often quickly rot, particularly those containing sapwood.

It is safe to say that every railroad in the country should at all times carry on hand an eighteen months' supply of oak and other hard woods and a twelve months' supply of fir, pine and other soft woods. All this material when received should be properly piled for air seasoning, and in the case of cedar material used for important parts, such as car sidings, should be run through the dry kiln just prior to use.

Increasing attention has been given in recent years to the preservative treatment of certain parts of freight cars, and experiments have been made by some of the more important railway systems in the treatment of such items as stock-car decking, side and intermediate sills, roofing, etc. While these experiments have not been conducted for a sufficient length of time to determine actual results, the indications are that the preservative treatment of such car parts as are particularly liable to decay is profitable and will shortly be adopted as standard practice by the more progressive railroads.

Japanning Equipment

Object and Principal Constituents of a Japan — The Baking Process and the Machinery Used—Methods of Recording and Maintaining Proper Temperatures

By C. W. STARKER

JAPANNING is a process very extensively employed for giving a protecting coat and a pleasing appearance to parts made from sheet metal or castings. It is used extensively in the automobile industry as well as upon many small articles, such as typewriters, adding machines, electric motors, etc. The finish may be glossy as in the typewriter, or it may be dull as in the telephone. Black japan is the most commonly used, but different colors are obtainable.

As compared with air-drying finishes, the baking method, in which the articles are coated and then placed in an oven to be baked at temperatures ranging anywhere between 120 and 500 deg. F., results in finishes which are more elastic and durable, besides presenting a better appearance.

The japanning process appears simple enough on the face of it, but it requires careful attention to a number of points in order to secure uniformly good results, and the equipment must be carefully adapted to the individual needs.

The first essential is to have a clear understanding of the nature of the material and the objects to be accomplished. Commercial japans consist of an oxidizing or drying oil, generally linseed, which forms the body of the coating and gives it the required flexibility, and a coloring medium, which in black japan of the higher grades is obtained by the use of asphaltum, and in the cheaper grades by black pitch.

For priming coats carbon black is frequently employed on account of its ability to give a particularly dense coating to the surfaces and to cover the edges of metal parts. Further, we have a solvent for a thinning medium, for which benzine, turpentine or naphtha is used, the object of which is to facilitate the application. In the baking process, or in the preceding drying, these solvents are volatilized.

Special drying materials are sometimes added to the japan to accelerate the process, but, unless they are correctly applied, are apt to be a source of trouble. With modern facilities for baking there is little necessity for their use.

The principal constituents of a japan are, therefore, an oxidizing oil, gums or pitches, a coloring medium and a solvent; and the process taking place in baking is two-fold: namely, a volatilizing of the solvent and an oxidizing of the oil. It is essential to keep this two-fold action in mind as we will see later.

Care in Selecting Ingredients

The object of japanning is to provide a rust and wear-resisting coating. The coat must, therefore, be hard enough to resist scratching and flexible enough to stand reasonable handling and wear. From the standpoint of appearance it must be uniform, free from impurities, and from pitting or burned spots.

The linseed oil is an essential item of the cost as well as of the quality of the japan. An excess of it tends to produce a less glossy but a more durable finish. The cheaper japans, therefore, are apt to be more brilliant, but they give only a thin protecting coat to the metal and are more liable to crack off.

The viscosity or gravity of the japan—that is, the amount of solvent added to it—is next in importance. The proper quantity for each individual brand of japan should be determined by testing samples with varying proportions of japan and solvent. Commercial japans contain about 50 per cent of solvent and it is customary to add between 15 and 40 per cent more to facilitate dipping or spraying in manufacture. Once determined, a standard gravity should be maintained and strictly controlled in manufacture to secure uniform results.

The room temperature should be uniform as this affects the flow of the japan. If the temperature is low less solvent is required and if high the solvent tends to evaporate.

There should be proper facilities for mixing and storing japan, and tanks should be provided which permit the settling (in water) and the drawing off of impurities. Means should be provided for agitating the japan to prevent settling of the heavier ingredients. The air should be free from dust.

Exhaust Fans Important

Because of the combustible nature of the constituents and their tendency to volatilize, tanks must be covered and lights and flames protected. The fumes in spraying must be carried off by exhaust fans and the baking ovens must be ventilated; arranged so as to draw off the heavier vapors near the bottom and the lighter vapors, together with the heated air, near the top.

A careful study of the amount of air required to produce proper oxidizing and to prevent dangerous explosive mixtures is very desirable. Means for controlling the air supply should be provided. Eight to fifteen changes of air per hour are usually figured on in baking. A uniform finish, absence of overheated or insufficiently baked spots, requires that the temperature should be closely controlled and that definite baking times be established according to the requirements of the piece to be japanned, and depending upon the japan as well as upon the thickness and weight of material. These points will be referred to more in detail in discussing different constructions of japanning ovens.

The Baking Process

The ideal baking process would be one in which the metal is heated first and the japan baked, so to say, from the inside out. Present practice does not reach this ideal but approaches it by using a uniform slow heat, indicating that slower heating—that is, a longer baking time and comparatively lower temperature—are preferable to quick baking at high temperature.

Practice varies considerably in this respect. With black japans, temperatures of 300 to 400 deg. F. are ordinarily used, with baking times of three to one and one-half hours. On the other hand, temperatures of 450 to 500 deg. F., with baking periods of 45 to 30 minutes, are employed by many manufacturers to secure

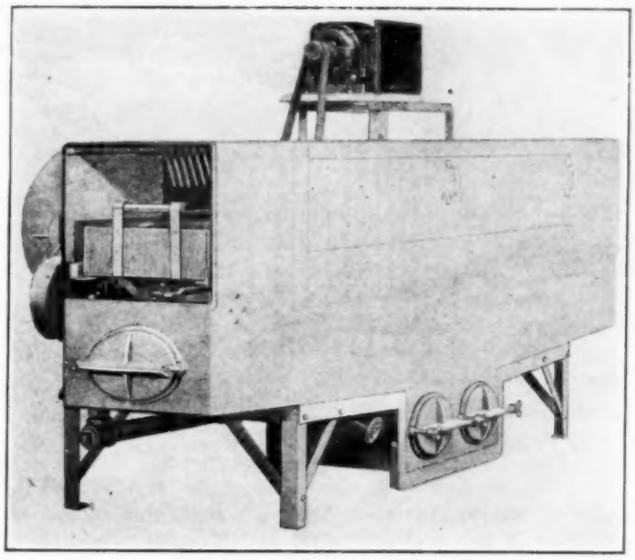


FIG. 1. WASHING MACHINE FOR SMALL PARTS

a maximum of output. White or light colored enamels are particularly sensitive and are baked at lower temperatures to prevent discoloring.

One other point is worth mentioning here: The best japan cannot produce a uniform coating on an unclean or greasy surface, and the cleaning of metal parts before japanning is essential. Particularly is this true when preceding operations have been performed on the punch press, because of the lubricant adhering to the parts. Cleaning by dipping the parts in benzine or washing them with a benzine-soaked cloth by hand is necessarily slow and expensive and the fire risk is also an item to be considered.

With small parts, an automatic washing machine is particularly advisable. One well suited for small punched parts or screw machine parts is shown in Fig. 1. The parts are placed in baskets and are pushed first through a washing compartment and then a rinsing compartment; to which may be added, if desirable, a gas-heated drying compartment. Another type of machine suitable for cleaning larger parts, such as automobile fenders, range parts, etc., is shown in Fig. 2. This machine provides a washing and a rinsing compartment in which strong jets of hot cleaning compound are applied from both sides and from below. The parts are moved along on a chain conveyor, the latter, as well as the spraying nozzles, being operated by electric motors. One or two operators on a machine of this type may replace five or six operators cleaning by the hand method.

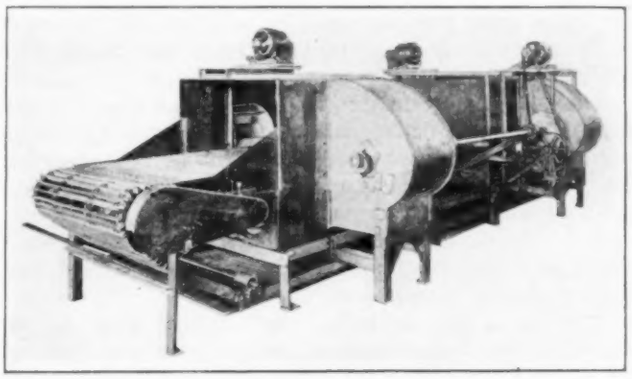
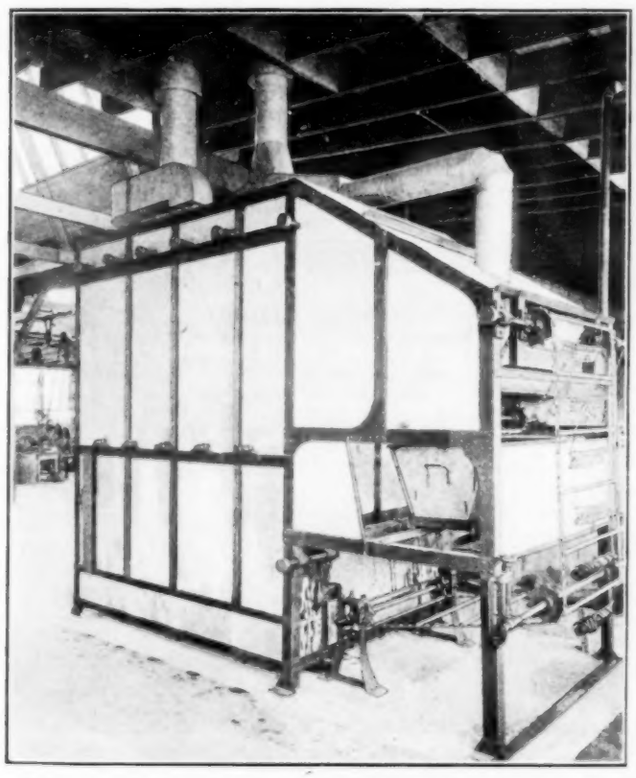
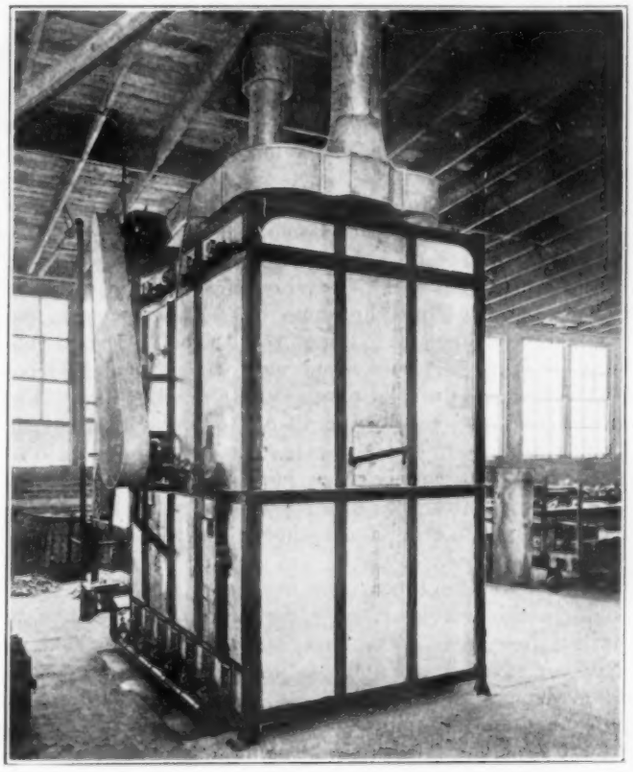


FIG. 2. WASHING MACHINE, WITH CONVEYOR, FOR LARGE WORK

Cleaning metal surfaces by burning off oil and grease with hot air at approximately 500 deg. F. for 10 to 15 minutes has also been tried with success. Neither of these methods will, of course, improve the surface of the metal itself. If the steel shows imperfections, burns or scratches, they are apt to show up in the finished article, so that where good appearance is desired a metal





FIGS. 3 AND 4. FRONT AND REAR VIEWS OF BAKING OVEN WITH CONVEYOR FOR DIPPING AND PLACING WORK

having a good surface must be selected. With brass it is particularly important to have the parts well cleaned.

The next important item is the size and shape of the oven; this being dependent upon what method is to be used in handling the work. It might be recommended not to decide arbitrarily on a size of oven and then to determine how best to load it, but rather the reverse; that is, decide on the size and shape of truck or conveyor most suitable for the articles to be japanned, and then build the oven around it.

Assuming, for example, that the articles to be japanned are wire wheels or range parts and that we decide on a truck-loading oven, we would select a standard truck, or if necessary, design a special truck in which the various parts can be most economically supported during the baking process. The size of this truck then would determine the inside dimensions of the oven.

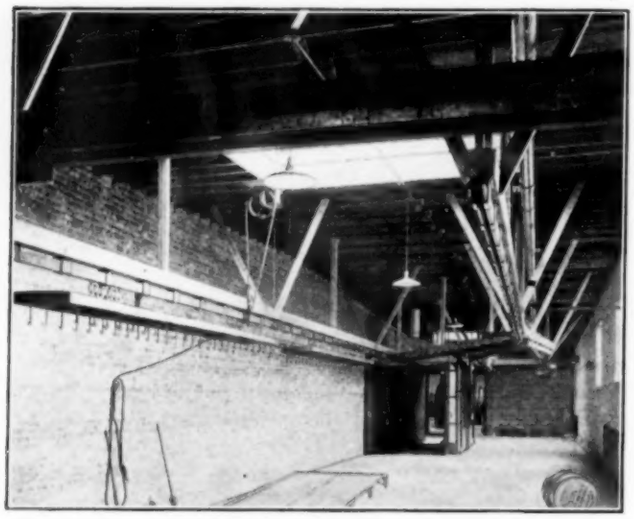


FIG. 5. MONORAIL SYSTEM OF CONVEYOR FOR BAKING OVENS

Where the product is of a varied nature the truck size would be determined by the larger or more important items and shelves or supporting rods would be provided to accommodate the other parts as economically as possible. The aim must be to fill the ovens as completely and uniformly as possible each time.

Parts of different size or weight require different baking times, and this point should be kept in mind so that parts requiring the same baking period may be grouped together in loading the trucks. From this point of view it would seem most economical to have relatively small units of ovens—their number depending on the required total output—or to have large ovens divided into a number of compartments so that the oven space and heat may be used most economically all the time. In operation the aim should be to always have a load in the oven, other trucks being loaded and unloaded in the meantime.

Instead of the truck, the overhead track and, particularly the conveyor, have come into prominence in the last few years. The question of whether a truck or conveyor is most suitable is entirely a matter of handling, depending upon the nature of the work and the general manufacturing plan. This point, therefore, should be considered entirely aside from the oven construction and a decision should be made strictly on the

FIG. 6. REAR VIEW OF OVEN WITH MONORAIL LOADING DEVICE

basis of saving in labor for each individual case. A conveyor is an excellent thing under certain conditions, but may be economically wrong under other circumstances.

The example of installation in other industries should be judged critically and with freedom from the tendency to follow a fad.

A conveyor involves considerable expense and of necessity requires considerable floor space, particularly if the continuous conveyor be selected. In this type of conveyor oven, shown in Figs. 3 and 4, the conveyor travels at a uniform, usually adjustable, speed—say two to three feet per minute—and the oven portion necessarily has to be long enough to give the required baking time. In addition, there must be sufficient conveyor space outside of the oven to permit loading and unloading.

Two or more ovens may be arranged in parallel, or, still better, in series, so that the parts, after passing through the oven for a first coating, may be dipped or sprayed and passed through additional ovens for additional coatings. With the conveyor oven, the so-called intermittent type, the oven may be shorter, as the conveyor stands still during the baking time, and while one portion is in the oven the conveyor is loaded at one end and unloaded at the other end.

An overhead monorail, as shown in Figs. 5 and 6, or a conveyor, as shown in Fig. 7, would be best suited

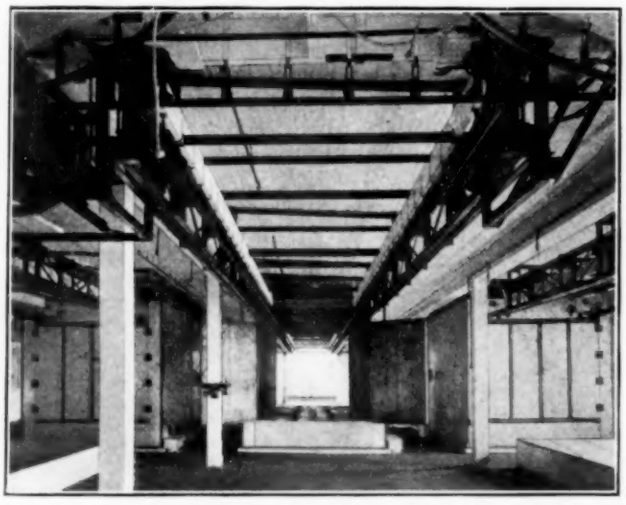


FIG. 7. THREE BAKING OVENS WITH OVERHEAD CONVEYORS

where it is possible to carry the parts on the conveyor from one department, through the japanning department to another department without taking them off. Where it is necessary to bring the parts into the japanning department on a truck, take the parts off the truck and hang them on the conveyor and, after baking, take them off and put them back on the truck, it is obvious that there will be a great deal of handling and the advantage in the use of a conveyor is questionable.

One advantage of the conveyor in general should not be forgotten; namely, the incentive to the operators to work according to a fixed schedule and have the slower man speed up to keep pace with the faster man. Graphic recording instruments may be provided which show exactly how long the oven has been open, how long the parts were in the oven; how the temperature varied, and how much time was consumed in reloading. Records made by such instruments are shown in Figs. 8 and 9.

Source of Heat

Having decided upon the method of handling, the construction of the oven should be considered in detail. Among the different means of heating, steam is not used extensively, although steam heating coils distributed on the sides of the oven give a good indirect heating effect. When low temperatures are used and fast production is not essential, steam can be applied very satisfactorily.

Gas and electricity are the principal sources of heat. Of the gas ovens, there are two general types: the one using open gas burners installed under the floor of the oven, and the other, the indirectly-heated oven, in which the gas burners are contained in a closed compartment along the lower part of the sides of the oven, and from this compartment flues extend along the sides, from which the heat is radiated. The direct-heated type of oven has been practically superseded by the indirect-heated type; as the former involves a greater fire hazard and also because the latter better provides the uniform heat essential to good results.

Atmospheric pressure is generally sufficient to insure a circulation in the oven but in some cases, as with a battery of several ovens, pressure blowers may be required. The air supplied to the oven should be preheated by having it enter by a pipe passing through the combustion chamber.

The products of combustion should never be allowed to get into the oven. With the direct-heated oven the sulphur and other products of combustion are likely to injure the japanning and the air consumed by the gas burner materially decreases the amount available for the oxidizing process. With a separate combustion chamber, these disadvantages are avoided.

Electrically-heated ovens have come into use to a considerable extent. The question of gas versus electricity for japanning ovens should be decided strictly on a basis of relative merits. Electric heating has the advantage of cleanliness, convenience, and ease of control.

One important item in comparing gas with electricity for heating is the question of cost. There are, unfortunately, so far as the writer can determine, no two installations in which all circumstances are identical except the supply of heat, so that a strict comparison could not be made. Even if full data were available it would be difficult to render a satisfactory judgment as the question of possible shortening of baking time and quality of resulting finish would be subject to differences of opinion. Further, the comparison would be of only local value inasmuch as the relative cost of gas and electricity is variable.

With electric ovens, it is the custom of several manufacturers to make the walls thicker than are the walls of the gas oven, on the theory that the higher cost of electricity warrants the additional expense for the insulating material used in the sides of the oven. This item materially increases the cost of the oven and is cited as an example of the difficulty in making comparisons. From the viewpoint of first cost, it should be noted that electric heaters and control are more expensive than gas burners. On the other hand, the electric heaters take less room so that the oven may be made smaller and the heaters can be distributed on the walls to better advantage.

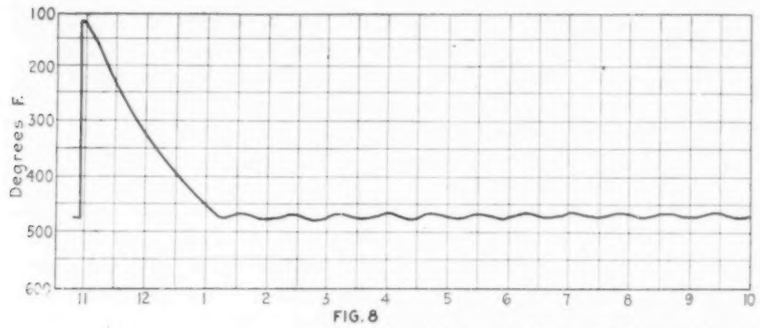


FIG. 8

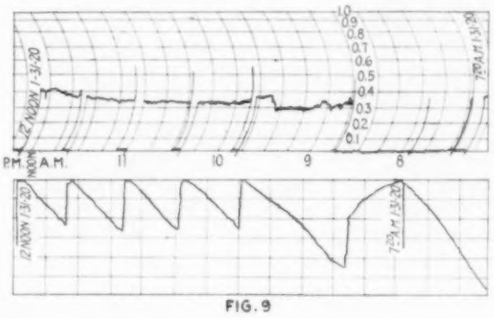


FIG. 9

FIGS. 8 AND 9. CHARTS FROM RECORDING INSTRUMENTS

Frequently the heaters are arranged in two sections: one section supplying the constant heat and the other supplying the peaks occurring after the oven is loaded. After a certain temperature is reached the latter section is cut off automatically and the heat is then maintained by the remaining sections. The maintenance cost is also an item to be considered in the individual case.

From all this, it is apparent that a comparison made merely on a thermal basis, that is, stating that 100 cu.ft. of gas contains 500 or 600 B.t.u. and costs a certain amount, while electricity with 3,412 B.t.u. per kw.-hr. costs so much, does not begin to tell the story and a full analysis of all the points entering into the problem, including incidental advantages, must be made. In calculating the amount of heat energy required, the weight of the conveyor truck should not be neglected as the material in them must be raised in temperature the same as the actual work being japanned. The heat losses in flue gases and air changes are also points of importance and are items which vary for gas and electric ovens.

In recent months the price of artificial gas has taken a decided upward turn, due mainly to the increased price of coal. At the same time, the quality of the gas furnished has, at least in the writer's experience, deteriorated both as to B.t.u. value and purity. On the

other hand, electricity is being produced more economically by the larger generator units installed, by interconnecting different systems, and various other economies. Special low rates for electric power used during the off-peak periods are made, so that in a recent investigation of a typical case the cost of energy for electrically-heated ovens was only a few per cent greater than for gas, and this difference could readily be shown to be offset by the incidental advantages of electrical operation.

The use of electric recording instruments and push-button control is one of the means by which the entire operation of the oven can be visualized graphically, showing just what takes place and where time or heat may be wasted. This feature is an excellent stimulus for most efficient use of the equipment and for uniform quality. It effects an indirect saving which should not be lost sight of. Under present conditions, a saving in labor in almost every case easily overbalances any difference that may exist in the cost of power.

It is a fact that most of the large automobile manufacturers have turned to electrically-heated japanning ovens. Many of them had made exhaustive tests and interesting cost comparisons. They have stated various percentages of increase in production, decrease in rejections on account of poor quality, and saving in floor space, all of which led them to decide upon electric ovens for additional installations. Much as gas has superseded coal, due to its convenience and incidental advantages in spite of the higher cost, so electricity appears to be gradually superseding the gas-heated ovens.

In conclusion a few words should be said in regard to spraying devices, which form an essential part of the equipment of the japanning department. Coating the parts to be japanned by immersion in a vat—so-called dipping—is an inexpensive method and is generally used on plain parts or for first coats, but very often parts are of complicated shapes or have holes and ridges which, if the dipping method were used, would leave marks or streaks of japan and result in an imperfect coating. In all such cases, air-operated spraying guns should be used and spraying booths installed, provided with exhaust fans. The parts to be sprayed may, to advantage, be placed on a turn-table so that they can be sprayed uniformly from all sides.

Knurling Small Pieces in a Vise

By J. A. Raught

The other day while doing some experimenting I found myself in need of some 8/32 fillister-head screws with knurled heads, and not having proper facilities for knurling such small pieces in a lathe I placed the screw head between two 10-in. mill files in a vise and with a wooden mallet drove one file endwise for about ½ in. by striking the blunt end of the file. This produced the desired results in a very short time. I also tried this method on several other small pieces for experiment; including a small wire nail which would be by far too weak to knurl in any other way.

In trying out this stunt a piece of wood should be placed between the vise-jaw and the file that is being driven to prevent spoiling both file and vise.

[Our correspondent sends several samples, all of which show a very good job of knurling. What must have happened to the files is another matter.—Editor.]

Should Jigs and Fixtures Be "Designed"?

By P. A. Fredericks

During the past five years the writer has had experience with two plants using radically different systems of production for jigs and fixtures. In view of the fact that both systems seem to produce results it appears worth while to raise the above question for discussion.

Both plants are doing almost identically the same class of work, namely building a fairly heavy machine tool in quantities sufficient to be classed as production work and therefore requiring to be well tooled up.

In the first plant the jigs, fixtures, etc. are all designed and detailed in the drafting room, down to the last screw. In the second shop the piece to be machined is sent to the pattern shop to have the pattern for the jig built around it and when the casting comes in, the toolmaker works from the blueprint of the part in locating holes, etc., without even a sketch of the jig itself beyond possibly a few scratches to indicate the general plan to be followed.

If one believes either of these shops, the other one must be nearly if not quite crazy to use its present methods; yet having seen both methods used I believe there is something to be said for each.

The plant where the jigs and fixtures are laid out in the drafting room and all the details drawn, has a much better opportunity to analyze the fixture for possible improvements. It is certainly cheaper to build jigs and fixtures from drawings, since the various parts can be routed and some of them worked up by the least expensive men. There is also the possibility of getting out tools in advance for new product where the other plant would be waiting for castings to start building the fixtures around; then, too, the system embodied in drafting room design does not require so much in the way of training employees as does the other system which would scarcely work at all except when there were men available in the toolroom who had been well trained in the particular methods followed in that shop.

However, the plant where the jigs and fixtures are designed and built in the shop will reply that there is much less likelihood of expensive interferences, for when the pattern is built around the piece it is certain that the piece will always go in and come out without trouble. A much smaller drafting force is required which largely offsets the gains the other shop makes in machining the jig parts from drawings. The fact that the men require training is a help rather than a hinderance, for it is more certain that standardized methods of machining and routing of operations will be followed; that the shop has to use the jigs and produce results with them and ought to be best qualified to know what it wants, and finally the fact that jigs or fixtures cannot be built until the castings come in is of no importance, since every wise shop builds an experimental machine and works out the jigs before starting to manufacture.

To the writer it appears to be largely a question of personnel. No doubt either shop would flounder around considerably if it had the system of the other thrust upon it suddenly, but I am strongly of the opinion that the proper place to design tools is in the drafting room and not in the shop. Jigs and fixtures can be successfully made by both methods.

Machining Columbia Rear-Axle Housing

Some Interesting Operations on Drilling, Boring, Reaming, Tapping and Special Machines —Press Work, Assembling and Testing

BY FRED H. COLVIN
Editor, *American Machinist*

THE Columbia type of axle consists of a trussed steel housing which is interesting as a matter of steel forming and machining methods. The complete axle with sections cut away to show internal construction, is shown in Fig. 1, while Fig. 2 shows above, a half housing, and below the housing with the two halves welded together and the tubular ends welded in place. Although not clearly shown, the trussing of the reinforcing ribs around the center opening is an interesting piece of work. The hole is first punched small and the metal drawn inward, after which it is folded back making a double thickness for threading during the tapping operation. The first operation is to test and straighten the housing in the fixture and under the presses shown in Fig. 3. The tubular ends run on roller rests while the pointers *A* and *B* show how true the ends run as the housing is revolved. If it requires straightening, pressure is applied by the rams *C* and *D*, each of which has an adjustable pressure point, so that the desired deflection can be secured with a constant stroke of the ram.

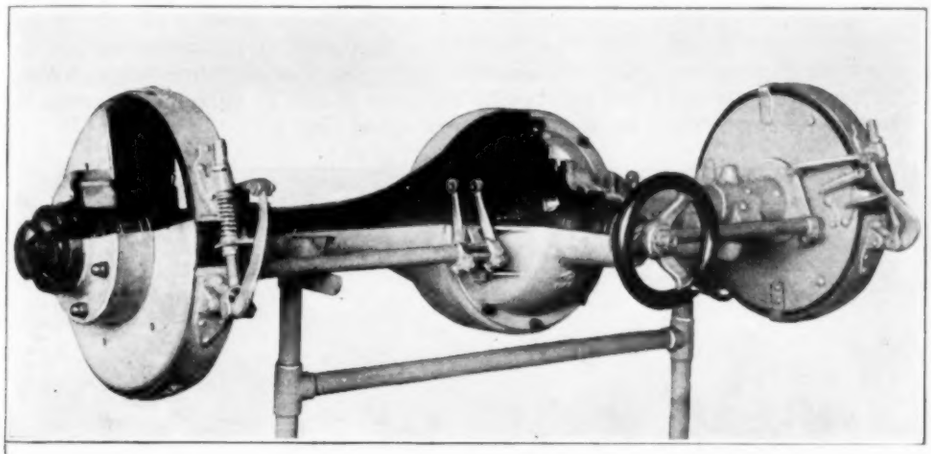


FIG. 1. THE ASSEMBLED REAR AXLE

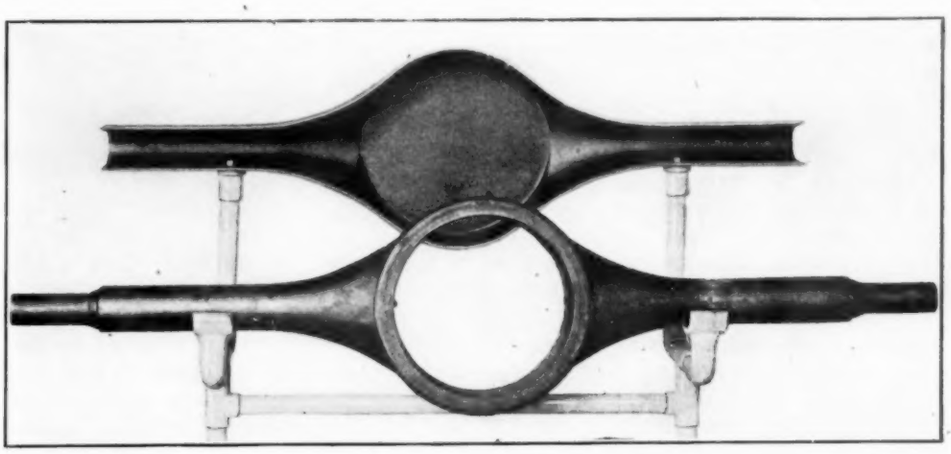


FIG. 2. THE PRESSED STEEL HOUSING

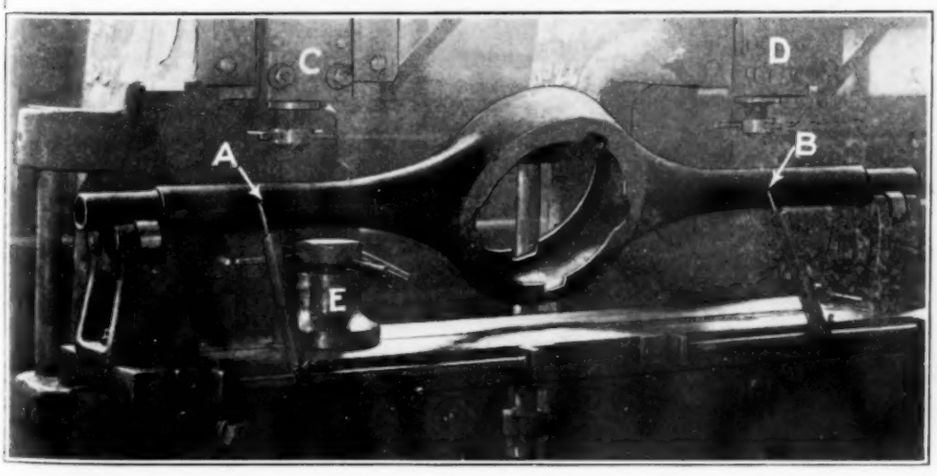


FIG. 3. TESTING AND STRAIGHTENING

When necessary, the substantial screw jack *E* is placed at the desired position to prevent deflection at that point. The inspectors and straighteners become very expert in handling the housings and they are straightened ready for machining at a rapid rate. Next comes the turning of the ends, Fig. 4, both for the spring seat and brake-band housings at *A* and *B*, and for the wheel seats at *C* and *D*. The housings are turned between centers in an engine lathe, a ball bearing dead-cen-

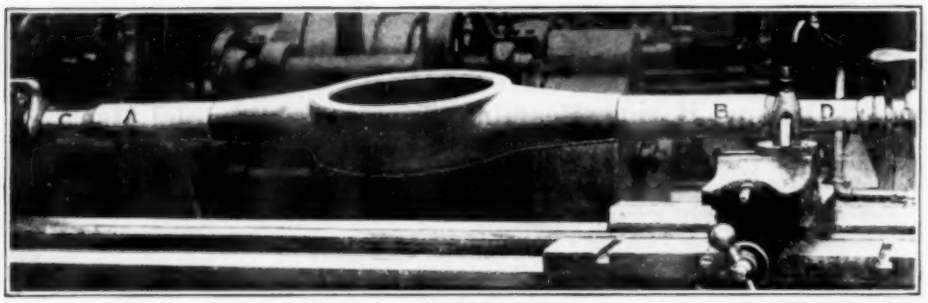


FIG. 4. TURNING THE ENDS

ter being used in the tailstock as shown in the halftone.

The special double-headed facing machine shown in Fig. 5, used for facing the sides for the differential units and the outside cap, is of especial interest. The housings are held against the V-shaped clamps *A* and *B* by means of pneumatically operated plungers operated from cylinders *C* and *D*. Stops are provided at the center, as at *E*, for holding the housing vertically and for taking the thrust of the cutting tool. Two cutting heads are used as shown at *F* and *G*, both being provided with star feeds. It is very necessary to have the housings held properly, so as to be faced by the removal of a minimum of metal as there is very little to spare in most cases.

The drilling and tapping of the housing does not involve any special operations, multiple-spindle drilling machines and the usual types of tools and fixtures being used. The pressing on of the housings which carry the spring pads and the internal and external brake supports is done as shown in Fig. 6. The housing is clamped on a substantial center, as at *A*, by means of a quick-acting strap *B*, while the malleable casting which forms the spring seat is guided by the block *C* so as to insure its being in the proper position. A compact horizontal hydraulic press is used in the usual manner.

This operation practically completes the housing proper and we can pass to the differential housing which carries the driving gears and the differential unit. The differential housing is shown in Fig. 7 being machined in a Gisholt turret lathe, the tooling being of the usual order.

Cross-boring the support for the inner axle bearing is done on the special double-headed machine, shown in Fig. 8. The housing is mounted on the mandrel *A* that squares it with the hole for the driving shaft, which has been bored in the previous operation. The face is clamped against the smooth surface of the fixture by the four straps shown while the dowel pin *B* positions it with regard to the crossholes. The boring bars are large and stiff and are supported in the substantial bushings *C* and *D*, enabling the work to be done in record time.

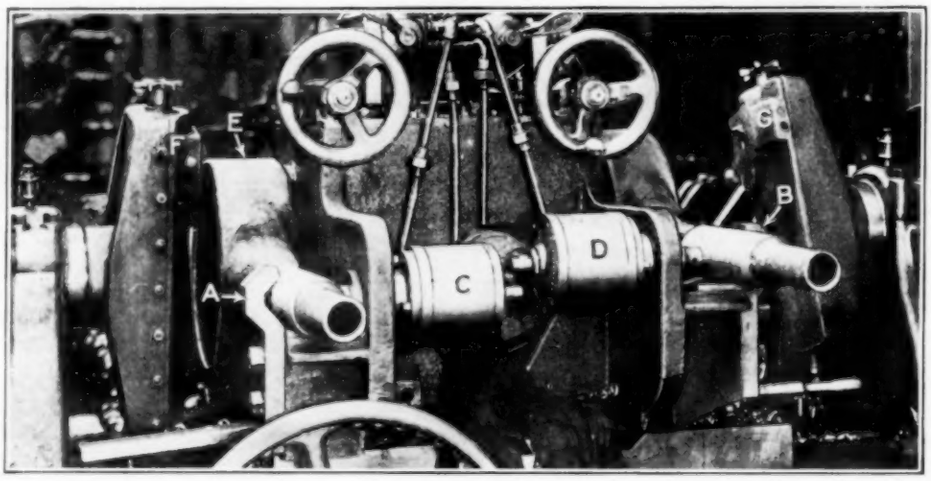


FIG. 5. FACING THE SIDES

The final reaming of the hole to receive the drive shaft bearings is done in the fixture shown in Fig. 9, the job being one of hand reaming in which the power is supplied by the air motor *A*. The work rests in the cradle *B* and is held in position by quick operating cams *C* and *D*. This secures the result of hand reaming without laborious work on the part of the operator. Another application of utilizing motor instead of hand power is shown in Fig. 10, where a similar air motor is used for screwing on the nuts, a friction chuck determining the amount of tension to be given.

This same type of stand is used in assembling the differential units as can be seen in Fig. 11. The quick acting cams allow the changes to be made very rapidly and at the same time the parts are held firmly while being assembled.

Before the business end of the rear axle is assembled to its housing, it is thoroughly

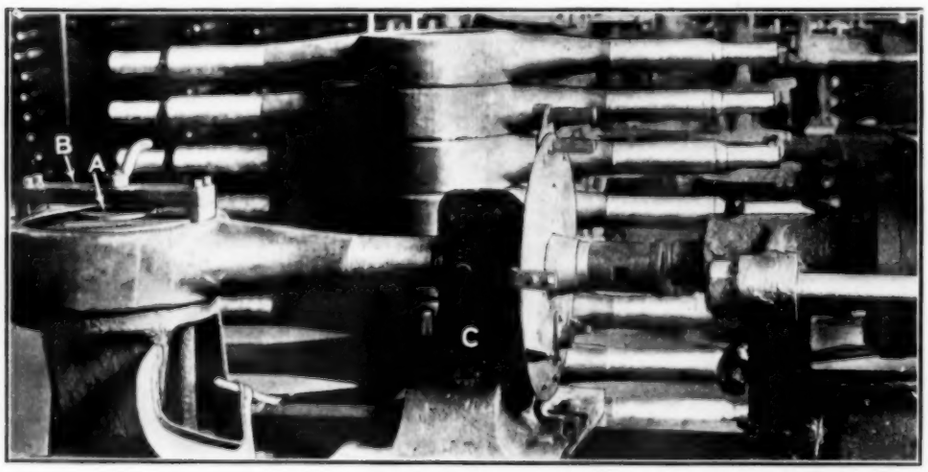


FIG. 6. PRESSING ON BRAKE HOUSINGS

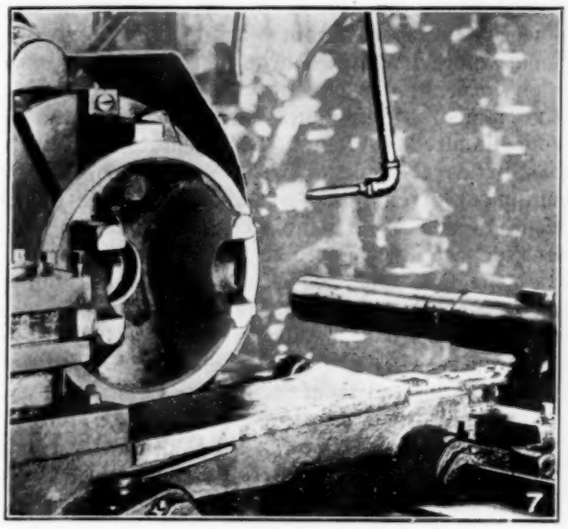


FIG. 7. BORING THE DIFFERENTIAL CASE

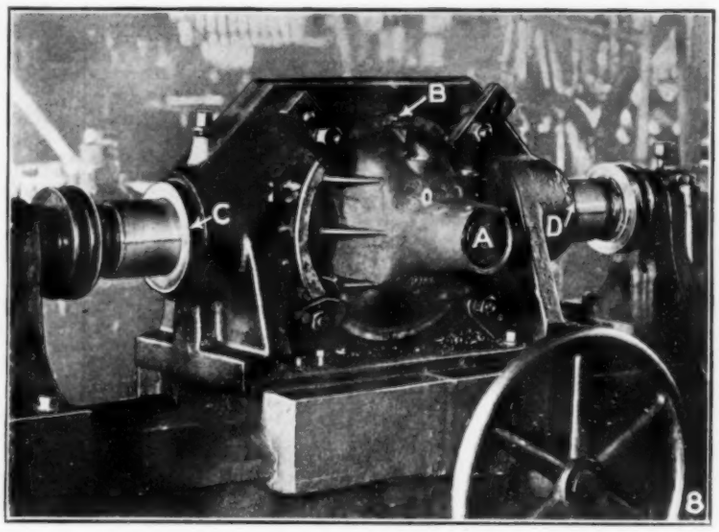


FIG. 8. BORING FOR AXLE BEARINGS

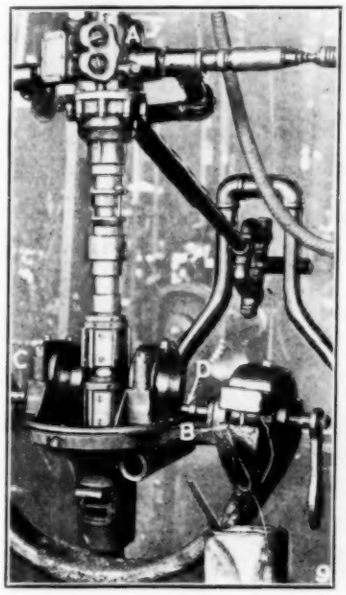


FIG. 9. FINISH REAMING DIFFERENTIAL CASE
FIG. 10. SCREWING ON NUTS BY POWER

tested on the stand shown in Fig. 12. The motor *A* drives the gear unit against the brake which is controlled by the lever *B* and necessary adjustment can be made to eliminate noise or to insure closer alignment. The motor controller is conveniently located at *C* where it is easy for the operator to handle. As will be seen with all the fixtures shown in the Columbia shop, the question of time lost in handling the work in and out of the fixtures has been carefully considered in every case.

Columbia Rear Axle

By Fred H. Colvin
Editor, *American Machinist*

Although the driving member of an automobile rear axle contains but two machining operations it is necessary to have them correctly done and in a reasonable time. Fig. 1 shows the turning operation which reduces the diameter of the axle for a portion of its length; a plain engine lathe with a substantial shallow follow rest being used for this purpose.

The ends of the axle are then splined in a hobbing machine and the piece heat-treated, after which it must be straightened before finishing by grinding.

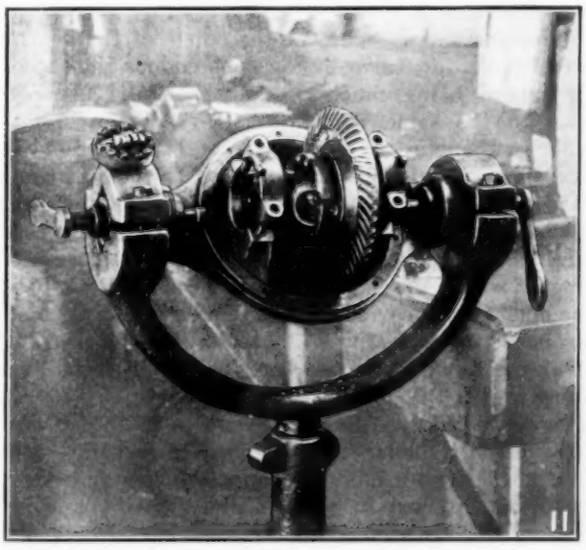


FIG. 11. ASSEMBLING THE DIFFERENTIAL

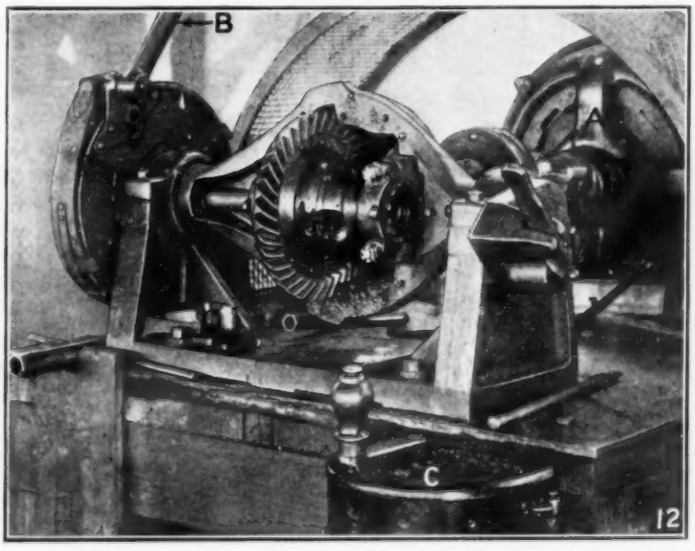


FIG. 12. TESTING THE GEARED UNIT

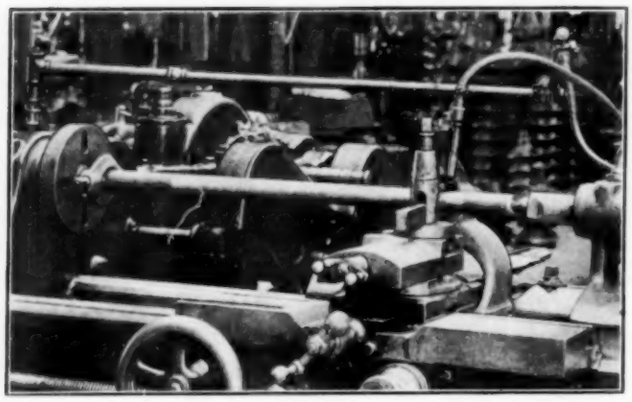


FIG. 1. TURNING AXLES

The straightening process is done very rapidly on a crank press as shown in Fig. 2, the first operation being to determine how much and where the axle runs out of true. For this purpose a pair of centers is hung on the

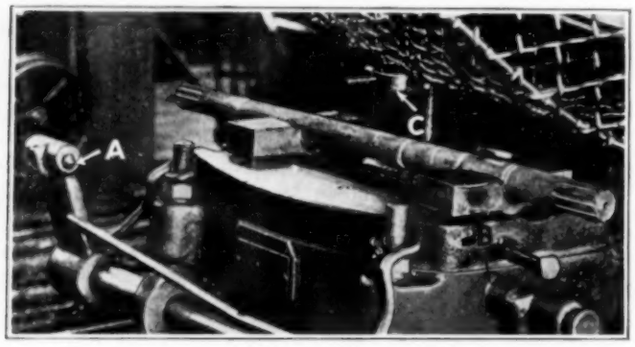


FIG. 2. STRAIGHTENING AFTER HEAT-TREATING

front of the press, the centers being shown at *A* and *B*. Rotating the axle on these centers allows the operator to mark the high spots, some of the markings being shown on the axle in the press. The press ram carries an adjustable tool C, which can be varied to suit conditions, and an experienced man will take the kinks out of a bent axle very rapidly.

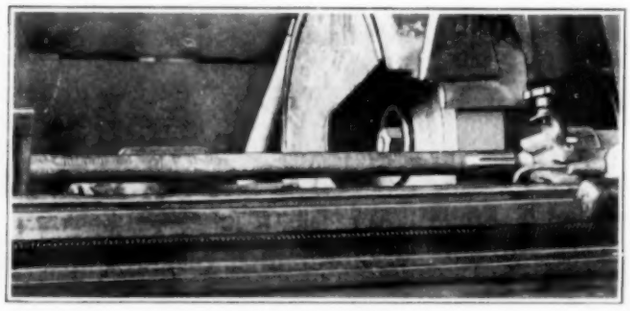


FIG. 3. GRINDING THE ENDS

After straightening the ends the axles are finished by grinding, as shown in Fig. 3, the central portions being left as they come from the turning operation, as the axles float freely inside the axle housing.

Maintenance Work on Aviation Engines

By John Houssman

Ordinarily, from work on rolling-mill machinery to that on jigs and fixtures for aviation motors would be a rather far cry, but under the stress of war and with a few good books one can always do more than that.

The work described herein was done at Fort Sill, Oklahoma, where I was in charge of the drafting office of the engineering department. As the field grew in size, the number of airplanes cared for increased to about one hundred. At first the machines used were 200-hp. Curtiss R-4 planes with V-2-3 type motors. The equipment of our shop was rather limited, but it was made to suffice. Then, too, the engineering department did not always receive the proper support.

Among the first tools made was the fixture, shown in Fig. 1, for testing the alignment of the bearings of the connecting rods of Curtiss motors. It consists of a cast-iron base *A* with four jack-screws *B*, the vertical ones being located from the bore *D* a distance equal to the length of the connecting rod.

With the jig are two clamps *C*, pin *E*, pin *F* and clamp *G*. Clamp *C* is made of spring steel about 3 in. wide.

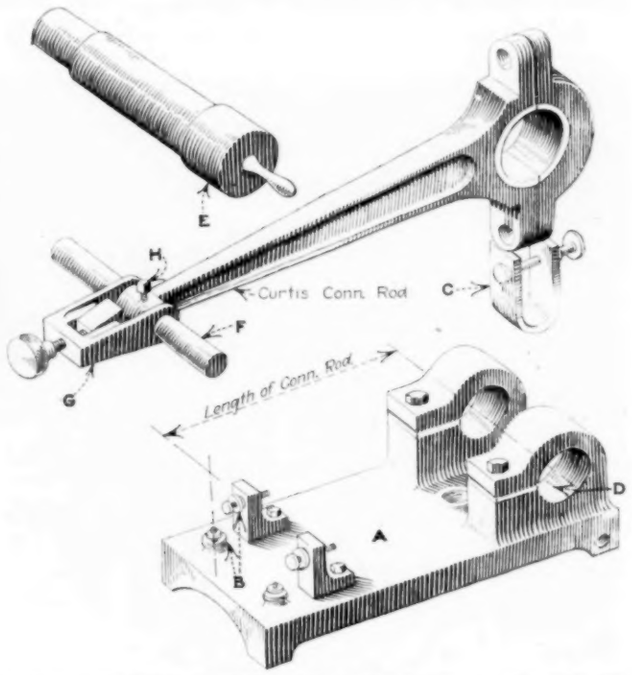


FIG. 1. FIXTURE USED FOR TESTING THE ALIGNMENT OF CONNECTING-ROD BEARINGS OF CURTISS AIRPLANE ENGINES

Uncompressed, it will go over the flange of the bearing and cap and a few turns of the knob clamps the cap on, this method being much quicker than the using of bolts. In the same illustration, *F* is a pin slightly smaller in diameter than the wristpin, but much longer; *G* is a clamp to hold the pin *F* in place in the connecting rod in the same position as the setscrew *H* holds the wristpin. The setscrew is not used while testing, although shown in the illustration. Pin *E* is of the same diameter as the crankpin on the motor shaft, it being made hollow and provided with a handle for convenience. A proper fit in bore *D* was assured by making provision for taking up wear, the saw-kerf being filled with lead, against which the bolts can be tightened.

The connecting rod bearings were lined with bronze-backed babbitt shells. After being scraped, they were tested in the jig for alignment in the following manner. Pin *F* was inserted in place of the wristpin and held by clamp *G*. The connecting-rod was placed on pin *E*, and its cap clamped on by the two clamps *C*. Then, the jackscrews *B* were screwed up against the pin *F*

and locked. Pin *E* was pulled out, the connecting rod turned over and the position of *F* on the screws was noted. Thus, the effect of any misalignment was doubled. In doubtful cases a feeler gage always told the story.

Almost from the start we were short of wristpins and, as new ones were not to be had, it was up to the engineering department to fix up the old ones. Each pin had a liner made from seamless tubing and expanded at both ends to fit the bore, the space thus formed between the pin and the liner receiving oil from the oil duct on the rod—the holes being held in alignment by the setscrews securing the pin in its place.

Investigation showed that the pins were worn about 0.002 in. on the diameter and that the only way to use them again was to expand them. A mandrel with a bulge on it about 0.005 in. greater than the bore of the pins was turned up, and then forced through the

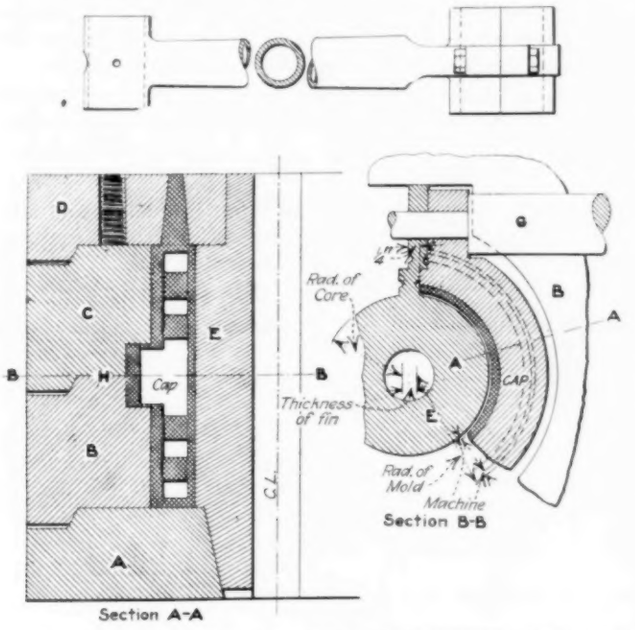


FIG. 2. INNER HISPANO-SUIZA CONNECTING ROD AND MOLD USED FOR BABBITTING IT

heated pins, using an arbor press for the purpose. The liner was destroyed, of course; but a new one was turned out of pipe and riveted in place after the pins were hardened and ground. The heat-treatment gave us quite a bit of trouble. At first the grain in the annealed pins showed very coarse in a break. From Halsey's Hand Book we settled upon heat-treatment *K*, judging temperature by color; and were rewarded by properties very closely resembling those of the old pins.

The expanding process was not entirely satisfactory, however, because it tied up too many motors while the pins were being expanded and because of the poor condition of the ends of the pins due to the action of the press. So it was decided to make new pins, the only material available being cold-drawn steel. The oil cellar was bored out straight in the pin. After carbonizing in cyanide, heat treating and grinding, the liner was pressed in and riveted in the chamfered ends. What the engineering department of the Curtiss plant would have said, I do not know—but we managed to keep the ships flying and had no accident due to changes we made.

One of the nicest jobs we did in making changes on some ships was to move the pilot into the front seat and to mount a machine gun in the rear. Not knowing the center of gravity, we worked about an assumed center of moments, taking care to have the pieces and parts that we moved produce the same total moments as they did before the re-arrangement.

Then came the time when the old machines were pronounced out of date and we received new ones, No. JN-4H with 150-hp. Hispano-Suiza motors.

Connecting rods of the Hispano-Suiza motor differ from those of the Curtiss engine quite radically. The Curtiss motor has two connecting rods working side by side on the same crankpin. In the Hispano-Suiza motor only one connecting rod works on the crankpin; the other has a forked end and works on the first connecting rod, which is babbitted for this purpose on the outside, as well as on the inside. The general shape of the inside rod is shown in Fig. 2.

The mold for babbitting the rods is also shown in Fig. 2. It consists of five main parts; the base *A*, the body halves *B* and *C*, the cover *D* and the core *E*. In use, the core was bolted between the connecting rod and its cap by the bolts *G*, these bolts being carried through the body of the mold to prevent an excess of babbitt from covering up their heads. The fins on the core separate completely the rod and the cap. The reinforcement around the cap and rod fits closely into the recess at the parting of the mold, as can be seen at *H*.

The center hole in core *E* was provided for heating up the assembled jig prior to pouring. After the core and the connecting rod were placed inside the half *B*, they were covered by *C* and *D*, which were then fastened to the base *A* by bolts. The opening around the stem of the rod was stopped with wet clay and each half of the jig was poured separately through the holes provided in cover *D*. The gate holes were made conical, as shown, to facilitate removing the cover, a setscrew in the tapped hole being used for this purpose.

Attention is called to the small grooves on the fins of the core at the point where the babbitt and the steel meet. Without the grooves the babbitt would not run closely into the corners, but the grooves permit it to form slight projections, which can be removed with a few strokes of a file, thus leaving neat joints. The grooves were about $\frac{1}{16}$ in. wide and $\frac{1}{32}$ in. deep.

The jig worked well and the excess of metal fell off after the bearing surfaces and the faces at *H* were machined. A simple fixture for holding the connecting rods while machining the babbitt was also made. It consisted mainly of a pin so located on the faceplate of a lathe that, when the wristpin end of the rod was placed over the pin, the crank end was held in the proper position for turning.

Simple Emollient for Burns

BY HENRY R. BOWMAN

In looking through the valuable booklet, "300 Practical Shop Kinks," in the section on heat-treating, I noticed several first-aid treatments for burns.

A simple and effective pain-killer and blister preventer is the scraped pulp of a potato of the Hibernian, or white, variety applied to the affected part.

An old boss blacksmith I once knew used to carry a "spud" around in his south-west pocket in case of emergency, along with a rabbit's foot and a cut of Navy Plug.

Designing a Wrench for Minimum Angular Movement

By Walter H. Wakefield

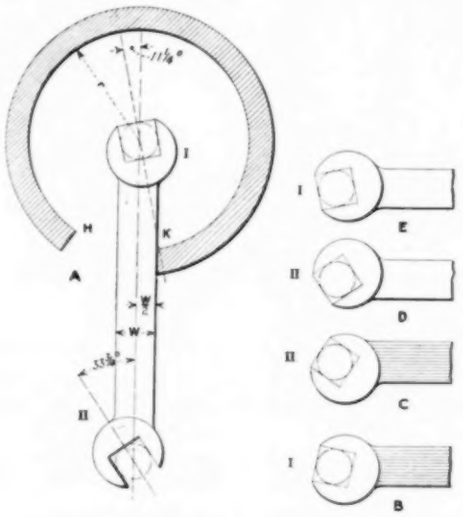
Occasionally a bolt is located in such a position that it can scarcely be turned with the ordinary S-wrenches. In such a case the writer was recently called upon to design a wrench which could be used in the smallest space possible, this condition requiring the least possible angular movement of the wrench as it was manipulated through different positions. It was permissible to have both jaws the same size and of course the wrench could be turned over.

One condition to be reckoned with was the relation between the center line of the handle and the centers of the jaws. Care was taken to have the center line of the handle pass through the centers of the jaws, as shown at *A* in the illustration. Were this not the case the wrench in successive turned positions would really occupy a space greater than its actual width.

Another consideration was that of the angles at which the jaws should be placed with respect to the center line. Reference to the figure will indicate how this was done. The bolt is shown located within a casing having a wrench-receiving opening the sides of which (*H* and *K*) limit the movement of the wrench. Since both jaws I and II fit the head of the bolt and the wrench can be turned over it follows that the jaws can be presented to the bolt in four angular positions. But during these four movements the bolt must be turned through 90 deg., therefore the motion for each position must be through an angle of 22½ deg.

When the wrench is turned over the angular displacement of the jaws in its successive positions is double the angle between the jaw and the center line of the wrench. As the angular position of the jaw is to be advanced 22½ deg. when turned over one jaw (I) is arranged at an angle of 11¼ deg. to the center line. Since two turns of the bolt are made with jaw I before jaw II is brought into play the bolt is 45 deg. from starting position and jaw II should be at an angle of 45 deg. ± 11¼ deg. to the center line. Reference to the diagram will show an advantage to be gained in making this angle 33¾ deg. The shaded and plain handles indicate the two sides of the wrench. Starting as at *A*, the wrench is moved to the left through 22½ deg., when it is turned over and jaw I presented to the bolt as at *B* and moved through another angle of 22½ degrees. Then, without turning the wrench over (because the angle is 33¾ deg.), jaw II is presented as at *C* and the bolt turned through a third angle of 22½ degrees. In the next position, *D*, the wrench is turned over, and after being moved through a fourth angle of 22½ deg., leaves the bolt in the position shown at *E*, which is the same as its position at *A*.

Passing to the general case of a bolt head or nut of *n* sides it will be seen that each sequence of four movements must turn the bolt through an angle of $\frac{360^\circ}{n}$. This angle must be divided by four to determine the angle through which the wrench must turn for each of these four positions, that is, $\frac{360^\circ}{4n}$. Since one-half of this is to lie on each side of the center line, the offset



THE WRENCH IN ITS SEVERAL POSITIONS

of one jaw will be $\frac{360^\circ}{2 \times 4n} = \frac{45^\circ}{n}$. The second jaw is offset to the center line an angle equal to one-half the total movement for each sequence $\frac{360^\circ}{2n}$ plus or minus the offset of the first jaw, that is $\frac{360^\circ}{2n} \pm \frac{45^\circ}{n}$. In the case of a hexagonal bolt head or nut, and following the general form shown in Fig. 1, the offsets would be 7½ deg. and 22½ deg.

It is to be noted that as the number of sides of the bolt head or nut increases the angular movement of the wrench for each setting, and hence the limits between which the wrench works, becomes smaller. The angular

movement corresponding to each position of the wrench is $\frac{360°}{4n} = \frac{90°}{n}$

Letting W represent the width of the handle, H and K the limits of movement and r the distance from the bolt to the limits, the distance between limits will be $\frac{2\pi r}{4n} + W = \frac{\pi r}{2n} + W$.

A Master Wheel and Tire Gage for Railway Shops

By J. H. Vincent

The master wheel and tire gage, illustrated in Fig. 1, was shown recently at the Chicago convention of the American Railway Tool Foremen's Association by William Casson, tool foreman of the Louisville shops of the Louisville & Nashville Ry. This working model is but a very short section of the standard size gage as the overall length of the complete gage is 6 ft. 6½ in.

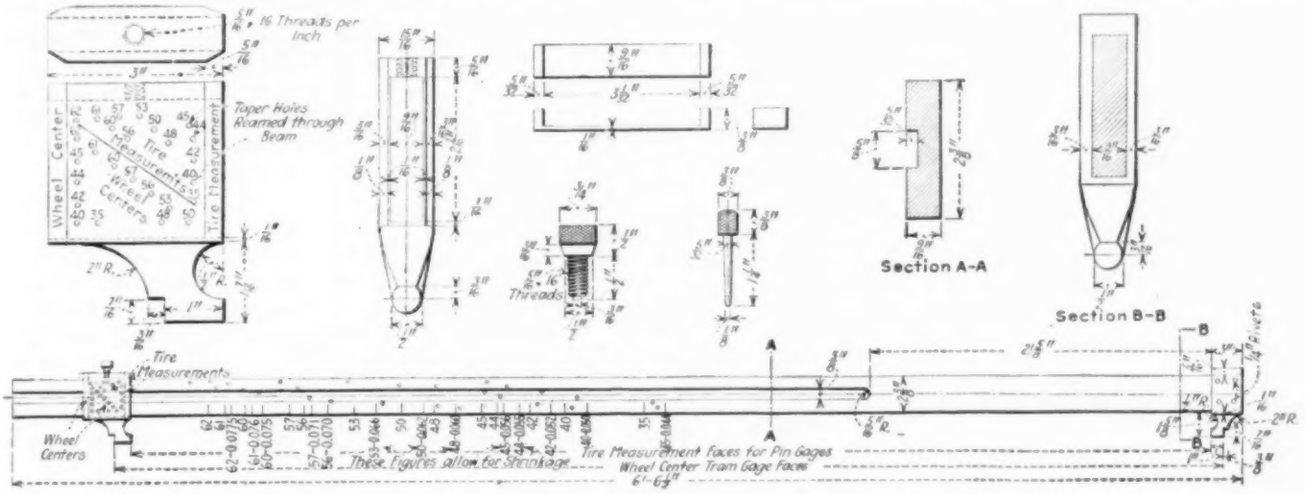


FIG. 2. CONSTRUCTION DETAILS FOR WHEEL AND TIRE MASTER GAGE

This gage is used for checking the calipers and gages used when turning wheels and tires, and does away with the necessity of employing a long steel scale. The complete details of the gage are shown in Fig. 2. It will be noted that dimensions and figures are given on this gage to allow for shrinkage of tires for securing wheel fits and this, in fact, is one of the great advantages attending the use of this master gage, since it obviates the necessity of any special figuring or direction for standardizing the shrinkage allowances.

The removable jaw of the gage slides the full length of the arm and is positioned by means of a taper pin which fits in holes drilled to correspond both in this part and the arm. After once being set in position it can be clamped up by the thumbnut located on its outer edge.

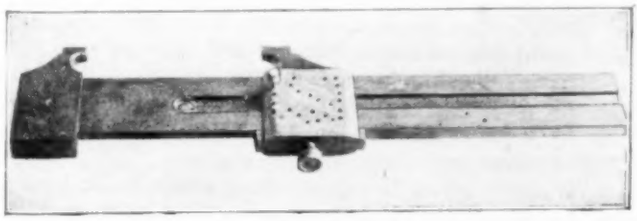


FIG. 1. MODEL OF WHEEL AND TIRE MASTER GAGE FOR RAILWAY SHOPS

Improvised Extension for Small Drills

By David Miller

Referring to the article under the above heading by J. C. Nicholson, on page 930, Vol. 53, of the *American Machinist*, I have used the scheme outlined by him of joining a drill to a piece of drill-rod by means of a closely wound spring, and have found that upon the application of any considerable pressure there is a tendency for the spring to break off at the joint.

If, instead of leaving the abutting ends of drill and rod square, as Mr. Nicholson advises, they are each beveled to an angle of, say, 45 deg., the joint will transmit more power.

A Veteran of Three Wars

By C. E. Kinne

I read with much interest an article under the above title on page 1032, vol. 53, of the *American Machinist*, telling of the discovery of an old lathe at Yonkers, N. Y.

In the shop where I am now employed (the Bagley & Sewall Co., Watertown, N. Y.) there is a 60-in. lathe with the name "William B. Bement & Sons, Industrial Works, Philadelphia, Pa.," cast on the tailstock. The shape and design of the tailstock, compound rest and tool-support, and the triple gears of the headstock, are almost identical with those shown in the illustration of this veteran lathe.

My guess is that the lathe you show was built by Bement & Sons.

Finding Decimal Cube Roots on the Slide Rule

By Henry R. Bowman

The slide-rule text books give rules for the proper scale on which to set a whole number of which the cube root is to be extracted, but they give no rules for setting a decimal number.

I derived the following rule which, as it has been of use to me, may benefit someone else.

$\sqrt[3]{0.1}$ — Right-hand 'K' scale
$\sqrt[3]{0.01}$ — Middle " "
$\sqrt[3]{0.001}$ — Left-hand " "

IN THIS ISSUE

WE PREFACE our paragraphs concerning the contents of this number with a few words on the 1921 dress of the *American Machinist*. The checking column of our contents page has been eliminated to give more space to the titles and short synopses. Bigger type is used for both, making the page more distinctive and the announcements of the editorial contents easier to read. For the heads a bold-face type replaces the light-face hitherto used. So-called newspaper sub-heads replace the italic synopses that have been a part of our general articles. We believe that these changes improve the appearance of the pages and permit an easier and quicker comprehension of what is to be found in the articles. The "What to Read" page has been given the new name, "In This Issue," and its scope has been enlarged to include a forecast of features for coming issues. "Sparks from the World's Industrial Forge" becomes "News Section" with the explanatory sub-heads Industry, Finance and Commerce, and the new head-piece is of one-page instead of two-page width. A 1921 feature of our news section is to be the financial page, the first appearing this week, page 40d.

The first article of the promised series on "Metal Cutting Tools," by A. L. DeLeeuw, opens this issue. It is introductory, yet covers a lot of ground, beginning with the simple tools familiar to all of us—pocket knife, hatchet and razor—showing the analogy between their cutting action and that of metal cutting tools, explaining chip formation, setting forth the necessary properties of cutting tools and specifying what must be done to secure the greatest amount of work before the cutting tool breaks down.

Beginning on page 8, an English correspondent, R. H. Worthy, in "Trigonometry for Toolmakers" supplies simple formulas applicable to the toolmaker's daily work. He shows how to solve right and oblique triangles and how to lay out angles without a protractor; gives formulas for use in connection with the segment of a circle and a circle inscribed in a triangle, and explains the principles of wire measurement.

Another of our short stories on boxing for export appears on page 12. We want our readers to appreciate the importance of having a sturdy case around a machine going overseas and the necessity for careful and thorough slushing of bright parts.

The United Shoe Machinery Co., Beverly, Mass., has a co-operative system of apprentice training that is explained in the eighth installment of J. V. L. Morris' series on "Programs of Apprenticeship and Special Training." An arrangement of alternate weeks in shop and school forms the basis of this system.

L. D. Staplin in "The Application of Babbitt Metals," page 15, gives information on anchorage, shrinkage, alignment and grooving. He tells how to increase the density of removable bearings and of the effects of overheating. He says, "Many users of babbitt metal feel that it is only necessary to procure a good grade of metal and their bearing troubles will be over. This result does not always follow, as good metal carelessly applied, means eventual trouble in most cases."

In these days of much steel construction we are likely to assign our old friend "wood" to a somewhat inferior position. In many cases such procedure is justified, but it is not always so in freight car construction. Data are given by H. S. Sackett in his paper, "The Use of Wood in Freight-Car Construction," which indicate that the use of wood is still more economical than the use of steel even for open-top cars, but that the underframe and draft rigging must be made of steel, on account of long and heavy trains.

Equipment for japanning forms the subject for C. W. Starker's article on page 22. While all of us are accustomed to daily use of japanned articles, many do not know of the rather involved process necessary to produce good japanning and we are glad to afford this opportunity for enlightenment.

Fred Colvin, pages 27 and 29, tells about machining the Columbia rear axle housing and rear axles. Those who are following his automotive articles will be glad to add these two to their files. They are followed, page 30, by a short account by John Houssman concerning maintenance work on aviation engines.

We aren't going to say anything about W. R. Basset's article except that it is good, give you the title, "What to do About Inventories," and mention that it begins on page 40a.

Coming Features

We shall confine this initial announcement of coming features to three series that are to extend over a large part of our 1921 volumes, merely stating in passing that from the present outlook there are to be many meritorious one-part articles and that several of them are to appear in our next issue.

A. L. DeLeeuw's excellent series on "Metal Cutting Tools" will be run in alternate issues, the second installment to appear January 20. You are going to be much pleased with this comprehensive treatise on metal cutting tools.

Beginning with the January 27 number and continuing every other week, there is to be a series by Associate Editor Sheldon of the staff, on "Magnetic Chucks." There is much to be said of magnetic chucks and we think that Sheldon has said a great deal of it, and has said it well and thoroughly.

The other group is by Editor Colvin, under the title "The Foreman and His Job." It embodies suggestions for the foreman who wishes to go up the ladder and for firms that want better shop executives. The first story will appear January 20.

EDITORIALS

Need of Concentration of Product

THE UNPRECEDENTED DEMAND for nearly all machine products, has led us into a maze of uneconomical manufacture. One of the worst features of it is the multiplication of models of machines which has reached an extreme form in the automobile industry.

The great demand for passenger cars and trucks induced many new concerns to enter the field with new models to meet all possible demands of customers. Old concerns added new models to their lists in the endeavor to capture the trade of all classes of purchasers. Many makers now build several models, with 4, 6 and 8 cylinders and different wheelbases to suit all kinds of customers. Each model demands expensive production equipment.

The falling off in demand leaves these companies with a huge capital tied up in tools and fixtures for each model. The investment must be distributed over the output and when this is limited by division among several models, the fixed charges cannot be reduced to an economical figure. The concentration of tools, fixtures and effort on fewer models would make for greater efficiency and lower production costs. Instead of increasing the number of models of cars, the industry should reduce them as rapidly as possible. The example of the Ford business shows what can be done by concentration of effort.

In the days which are ahead of the automobile industry—and we are going to build millions of automobiles in the years to come—economical production will reach a point never before realized. Simplified designs and special machinery will cut costs in many ways. We shall have fewer models and consequently better cars for less money.

This all points to the re-equipment of automobile shops with more efficient machinery. It also means highly specialized machines in some cases. But in any event it means a market for many machine tools as soon as the necessary readjustment can be accomplished.

Deliver Us from All Extremists!

MODERATION in all things is a safe rule of conduct for men, for associations of men and for governments. In the last decade we have had plenty of proof of the soundness of this principle in a negative sort of way. The one big, outstanding recent example of the unwisdom of carrying a policy to extremes is the history of the militaristic policy of the late German empire.

Our own history shows case after case to prove the same contention. Not so very long ago the railroads ran wild in rate matters and roused the people to a pitch of indignation that resulted in the subjection of railroad rates to government control by the Interstate Commerce Commission. The railroad managers paid the penalty of pushing matters to extremes. But far from taking warning from the experience the railroads had just gone through, the Commission promptly swung to the other extreme and starved the transportation systems of the country to a point where their operation by the government became a war-time necessity. The transportation act of 1920 seems to aim at a middle ground and is therefore promising if not perfect.

The passage of the anti-trust acts represents another revolt of the American people against the carrying to extremes of the elimination of business competition. The dissolution of the coal and railroad combines is a result that has been brought strongly to our attention in the last few months.

Organized labor took advantage of the stress of war needs to force the closed shop on many of our industries. As a result we see the rapid spread of the open shop movement over the country.

But have other extremists taken warning from the reverses of their confreres? Most of them have not for we are facing the Sunday Blue Laws agitation of the Lord's Day Alliance, the compulsory metric propaganda of the organizations working for that national calamity, the anti-tobacco crusade, the red radicals and others too numerous to mention.

The worst of it is that any one of the extreme individuals or associations can do an immense amount of harm before public opinion is aroused to the point of action. And even then it may take some little time to squelch a movement that threatens our national safety.

The "let-George-do-it" attitude of the average American isn't going to save us here. Each man of us has to watch himself for symptoms of "extremitis" and at the same time be constantly on the alert to fight every extreme action on the part of others that comes to his notice. Vigilance is the price of security.

Maintaining Standards in the Big Machine-Tool Shops

IN THIS PERIOD OF READJUSTMENT it is gratifying to find many machine-tool building managers with progressive and forward-looking ideas.

Some of the stronger companies are rearranging their plants for progressive manufacturing, replacing the departmental system previously in use. Methods are being improved and everything is being done to lower production costs—except reducing wages. Men are considered the biggest asset and the organization is being maintained. Old and obsolete machines are being sold, for scrap if necessary. When it seems best these will be replaced by the best machines available for the particular kind of work.

Overhead costs in the shape of non-productive labor and unnecessarily complicated cost-keeping systems, are being cut. Records are being simplified. Materials are being studied both from the point of view of cost and of machining properties. In other words the manufacturers realize that direct labor is not over one-third the total cost of doing business and they are not trying to make all the saving in that direction. They are, however, planning on making labor more efficient, and fully expect to do so when quantity production is again possible.

SHOP EQUIPMENT NEWS

SHOP EQUIPMENT • NEWS •
A weekly review of modern designs and equipment

Descriptions of shop equipment in this section constitute editorial service for which there is no charge. To be eligible for presentation, the article must not have been on the market more than six months and must not have been advertised in this or any previous issue. Owing to the news character of these descriptions it will be impossible to submit them to the manufacturer for approval.

• CONDENSED • CLIPPING INDEX
A continuous record of modern designs and equipment

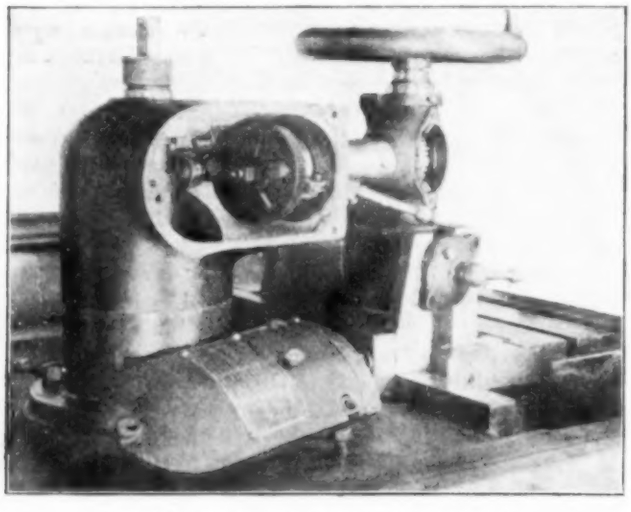
Change in Queen City Shaper

The Queen City Machine Tool Co., Cincinnati, Ohio, has recently made a change in the feed mechanism of its shaper. The illustration shows a view from above the mechanism, the covers being removed so as to show the working parts.

The feeding device consists of two units, the one on the bull-wheel shaft regulating the amount of feed, and the parts on the rail screw the direction in which the table travels. A face cam is mounted on the shaft of the bull wheel, the roller which bears on the cam actuating a pawl engaging a toothed wheel, so that the amount of the feed can be varied. The amount of feed is controlled by the adjusting handle, a stop acting to limit the swing of the arm carrying the roller. Sixteen different rates of feed are provided. When the feed lever is adjusted for zero feed, no running parts are in contact, so that no wear occurs.

The ratchet wheel drives the feed shaft through a friction clutch, incorporated for the sake of safety, so that nothing will be broken in case that the table is run to the end of the travel. The housing carrying the feed mechanism can swing about the shaft carrying the face cam, so as to allow of changing the position of the rail of the shaper. The length of the feed shaft connecting the mechanism with the rail screw is variable for the same reason, it being made of two splined telescoping parts.

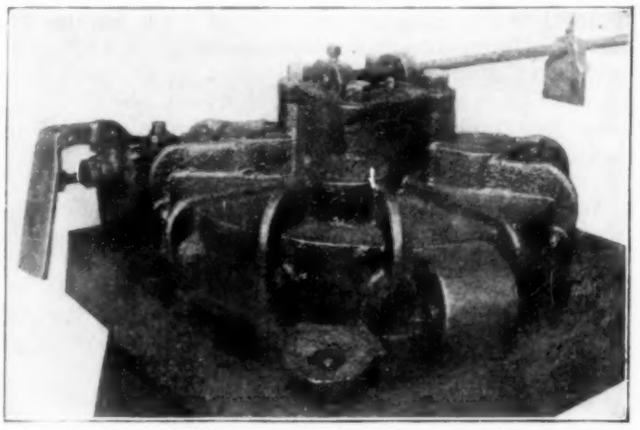
The lever on the reverse box is used to start, stop or change the direction of the feed, toothed clutches being used. The feed of the table takes place on the back stroke of the ram. The moving parts are inclosed and run in oil.



PLAN VIEW OF FEED MECHANISM OF QUEEN CITY SHAPER

Scully-Jones Pneumatic Rod Cutting Machine

The illustration shows a pneumatic rod-cutting machine recently placed on the market by Scully-Jones & Co., Chicago, Ill. The machine is intended for use wherever metal rods are to be cut, as in blacksmith shops, bolt factories, and foundry core rooms. It is operated by compressed air, a minimum pressure of 60 lb. per square inch being required. Steam can be used to operate the machine, no change in the mechanism being required.



SCULLY-JONES PNEUMATIC ROD CUTTING MACHINE

The machine is made in two sizes, one to cut rods up to $\frac{3}{4}$ in. in diameter and the other for rods up to $\frac{7}{8}$ in. in diameter.

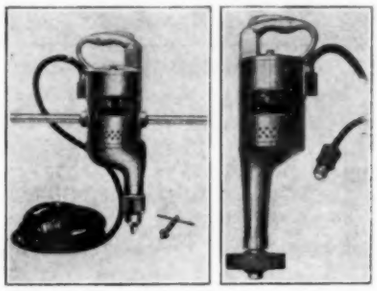
The operator of the machine causes it to actuate by pressing a lever with his knee, thus leaving his hands free. There are no other moving parts that the operator can touch. The shearing cutters are circular, so that when the edges have become dull at one spot, they can be rotated, in this way ten sharp cutting edges are supplied by each cutter.

It is claimed that the air consumption is low, because the travel of the piston in the small machine is only $\frac{1}{2}$ in., while it is $\frac{7}{8}$ in. in the larger machine. The machine may be installed on a permanent bench or on a portable bench on wheels, so that it may be taken to the work.

Wodack Portable Electric Drills and Grinders

The Wodack Electric Tool Corporation, 23 S. Jefferson St., Chicago, Ill., has placed on the market the portable electric drill shown at the left of the illustration. The drill is made in six sizes, the maximum capacities being $\frac{3}{16}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, and $\frac{3}{4}$ in., the $\frac{3}{8}$-in. tool being made in two speeds. The different sizes vary in length from 10 to 17½ in., and in weight from 6 to 16 lb.

The motor is series wound, fan-cooled, and of the universal type, operating on either alternating or direct current. The make-and-break switch is located in the handle, being closed by means of the pressure of the operator's hand. The circuit is automatically broken when the pressure is released, thus stopping the drill as soon as the hole is completed. The case is aluminum. The gears are of chrome-nickel steel and run in an oil-tight compartment. The shafts are mounted in self-oiling S. K. F. ball bearings.

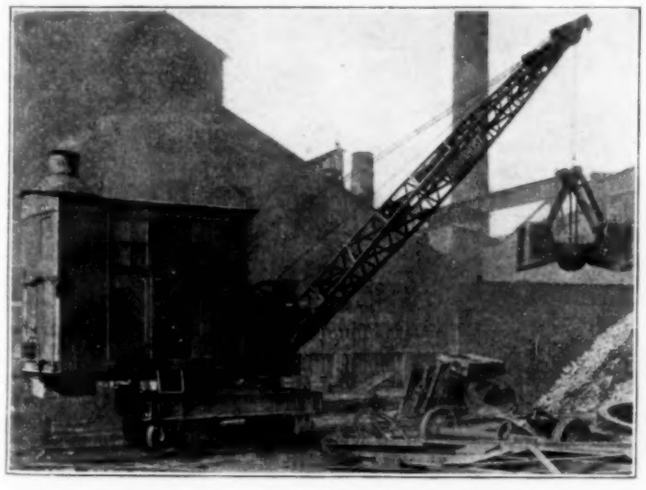


WODACK PORTABLE ELECTRIC DRILL AND GRINDER

A portable grinder, shown at the right, has also been placed on the market, the general features, such as the motor and the control, being the same as used on the drill. The grinder is made in three sizes, to carry wheels 3 x ½ in., 4 x 1 in. or 8 x 1 in. respectively. It is especially intended for smoothing castings, buffing and polishing. The tool, using a 4-in. wheel, runs at 5,000 r.p.m and weighs 13 pounds.

Brownhoist No. 2 Locomotive Crane

The locomotive crane shown in the accompanying illustration has recently been added to the line of the Brown Hoisting Machinery Co., Cleveland, O., as Brownhoist No. 2. In order to meet different working conditions, the crane is made to operate either by steam, by electricity, or by internal combustion motor, and it can be mounted either on a railroad truck, traction wheels, or a creeper truck. It is adapted to use either a grab-bucket, bottom-block, or bottom-dump tub; and it is said that the changes from one to the other can be made in a few minutes. The crane is self propelling and, when mounted on railroad trucks, can be used for switching cars. It is built to handle a one-yard bucket, or hook-loads up to five tons.



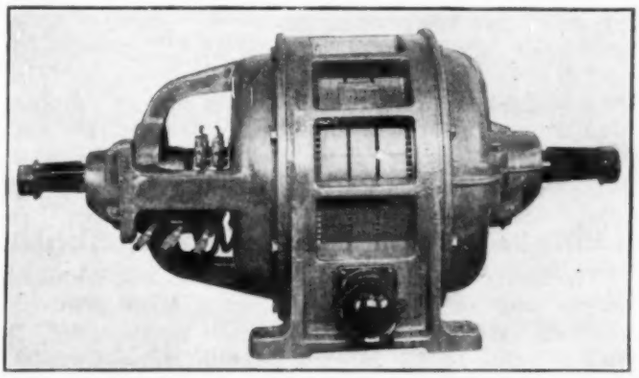
BROWNHOIST NO. 2 LOCOMOTIVE CRANE

General Electric M. T. C. Induction Motor

The General Electric Co., Schenectady, N. Y., has placed on the market a type of alternating current motor for operation on cranes and hoists. It is known as the M. T. C. motor, being intended to take the place of the former M. T. C. and I. T. C. types.

It is, as the illustration shows, generally smaller in diameter and greater in length than motors of the same horsepower of the former designs, thus reducing the flywheel effect of the armature. It is said to have larger shafts and bearings. As to the electrical characteristics, at rated frequency and voltage, it is stated that the maximum stationary torque is twice the running torque. All the motors of 40 hp. and less are rated on a basis of a temperature rise of 90 deg. F. (50 deg. C.) in 30 minutes, and those of 50 hp. and larger of the same rise in 60 minutes.

A resistor has been developed for work with the motor that leaves enough resistance in the rotor circuit, when the controller is on full, to cause the motor to run at approximately 89 per cent of full-load rated speed when delivering full-load torque. It is stated that the use of the resistor reduces the maximum current demand and protects the motor from abuse, either on the part of the operator or from abnormal working conditions.



GENERAL ELECTRIC M. T. C. INDUCTION MOTOR

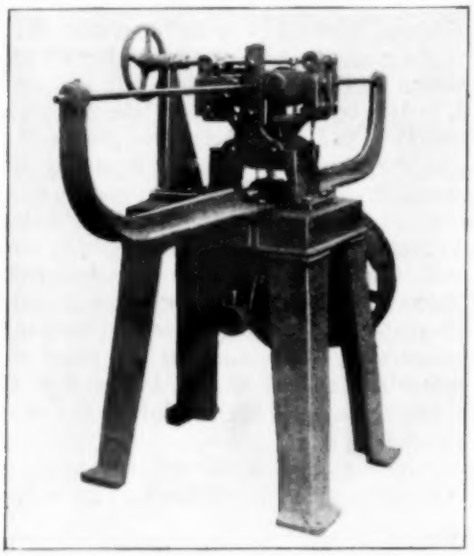
Kane & Roach No. 00 Rotary Straightening Machine

Kane & Roach, Niagara and Shonnard Sts., Syracuse, N. Y., has recently added to its line of straightening machines, the No. 00 rotary straightening machine, intended for handling round stock, either as tubes or as solid bars, in sizes from $\frac{3}{32}$ to $\frac{1}{4}$ in. in diameter. The stock is put into the machine through a tube, to be seen in the foreground in the illustration, and it then passes through the rolls in the center of the machine.

There are two hardened steel rolls, one convex and the

other concave along the periphery, so placed at angles to each other that in turning they revolve the material and also feed it through automatically. It is stated that the stock travels through at a rate of 50 to 75 ft. per minute, and that nearly all material is trued at one pass. A second pass can be used to take out any remaining curvature, if necessary. The handwheel at the side of the machine can be used to adjust the position of the rolls for the diameter of the work.

The machine will straighten stock anywhere from 8 to 10 in. in length up to 25 or 30 ft. long, if necessary,



KANE & ROACH NO. 00 ROTARY STRAIGHTENING MACHINE

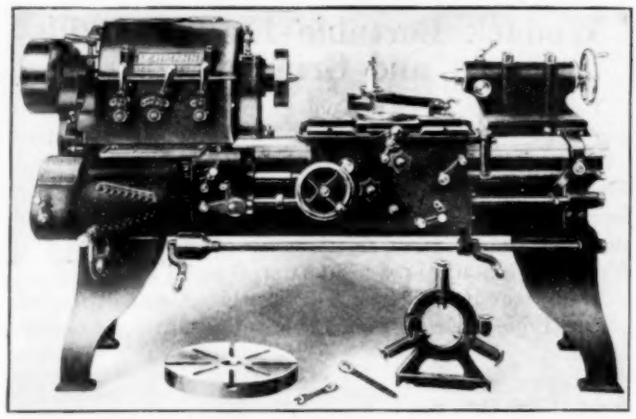
It is said that the machine is simple both in its operation and in its adjustment. It requires a floor space of 24 x 60 in., including the arms that hold the tubing through which the stock to be straightened is fed

Lehmann Geared-Head Engine Lathe

The Lehmann Machine Co., St. Louis, Mo., has added to its line the geared-head engine lathe shown in the illustration. The lathe is made in five sizes, the swings being 14, 16, 18, 22 and 24 in., respectively. It is stated that by using a moderate tooth speed for the gears the machine runs quietly at all times. There are ten heat-treated steel gears in the headstock, arranged to give sixteen spindle speeds in geometrical progression. It is claimed that it is impossible to engage different gear ratios at the same time.

All shafts in the headstock are high-carbon steel and run on ball bearings. Shafts are splined for all sliding members. The shifting parts are operated by rings running in grooves. The spindle is alloy-steel, with hardened bearings that run in bronze boxes. The spindle nose has a bearing surface in front and another behind the threads, both providing bearings for face or chuck plates. The back-gear clutch is secured to the spindle by four splines. The gear ratio is large, so as to permit the use of a high-speed driving shaft. The head forms an oil-tight case that encloses all running parts.

The friction clutches to give forward or reverse motion or to actuate the brake can be operated by levers both on the headstock end of the bed, and on the apron. The clutches run in an oil-bath, the exterior cone being hardened steel and the interior cone cast-iron. The lathes can be furnished in different lengths, and can be



LEHMANN GEARED-HEAD ENGINE LATHE

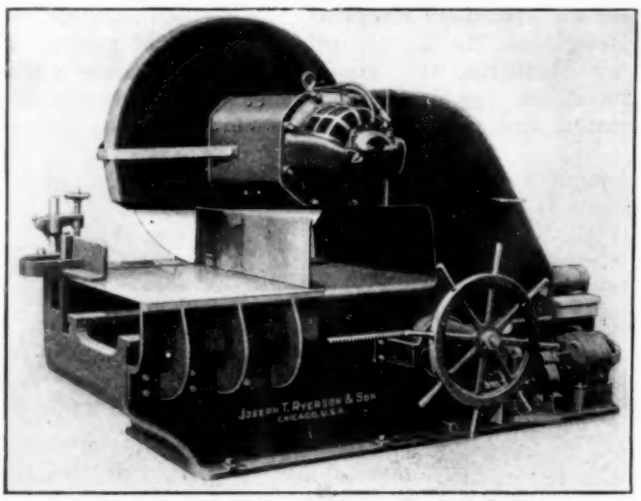
Specifications: Sizes, 14, 16, 18, 22 and 24 in. Maximum distance between centers with 9-foot bed: 16- and 18-in. lathes, 5 ft.; 22- and 24-in., 4 ft. Travel of tailstock spindle, 7¼ to 12¼ in. Maximum gear ratio: 16- and 18-in. lathes, 57.1:1; 22- and 24-in., 70.6:1. No. of spindle speeds, 16. Range of spindle speeds: 16- and 18-in. lathes, 10.5 to 412 r.p.m.; 22-in., 8.5 to 330 r.p.m.; 24-in., 8 to 310 r.p.m. Feed, 16- and 18-in. lathes: number, 56; range, 2¾ to 280 per in. Feed, 22- and 24-in. lathes: number, 63; range 1⅝ to 180 per in. Motor: speed, 1,800 r.p.m.; hp., 3 to 10. Weight: net, 3,450 lb. for 16-in. lathe; 8,200 lb. for 24-in.; boxed for export, 4,120 lb. for 16-in.; 9,000 lb. for 24 in.

arranged for either constant-speed or variable-speed motor drive. Taper attachments and follow rests can be furnished, although steady rests, thread-cutting dials and face plates are standard equipment.

Ryerson High-Speed Friction Saw

A line of friction saws especially designed for the cutting of structural steel is made by Jos. T. Ryerson & Son, Chicago, Ill., being particularly adapted to shops where a large volume of cutting is done. The machine has a heavy cast-iron base of box section, on which the carriage bearing the driving motor is mounted on rollers. The rollers are provided with roller bearings and eccentric pins, so as to provide adjustment for wear.

A large hood covers the saw, one side of it being mounted on hinges to permit of inspection and removal. The saw is made of soft steel, hollow ground on its sides and nicked on the edge to increase friction. It is cooled



RYERSON HIGH-SPEED FRICTION SAW

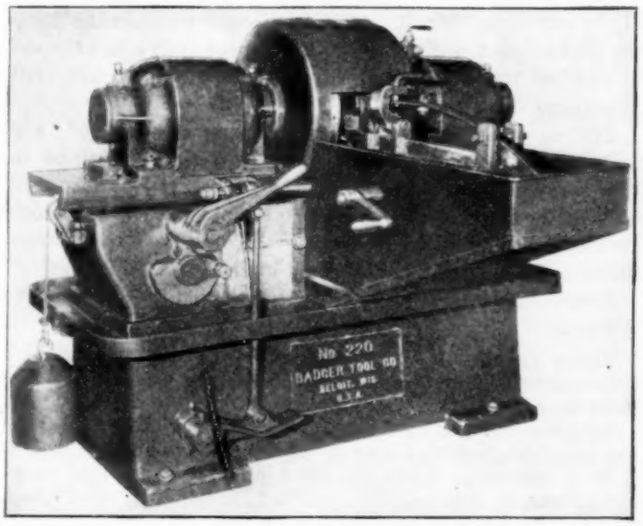
Specifications: Built in four sizes, Nos. 1, 2, 3 and 4. Capacity to cut I-Beams: No. 1, 12 in., 40 lb.; No. 2, 18 in., 65 lb.; No. 3, 24 in., 80 lb.; No. 4, 24 in., 100 lb. Diameter of saw: Nos. 1 and 2, 46 in.; No. 3, 52 in.; No. 4, 56 in. Size of motor, 25 to 120 hp. Height, 6 ft. 3 in. to 7 ft. 5 in. Floor space, 7 ft. 2 in. x 5 ft. 2 in. to 12 ft. 8 in. x 6 ft. 6 in. Weight with power feed: net, 5,740 to 12,650 lb.; boxed for export, 7,300 to 15,450 lb. Export box, 294 to 625 cu.ft.

by jets of water when in operation. The motor is entirely inclosed on the saw end, and the outer end is semi-inclosed to permit ventilation.

The carriage can be moved either by hand or by power. Power feeding is accomplished hydraulically by a cylinder and piston located at the right of the machine. A one-horsepower electric motor drives a gear pump to provide the pressure. A four-way valve gives the operator control of the carriage. In order not to overload the saw motor by too heavy a feed, a relief valve is incorporated in the feed line. The valve operates at a pressure corresponding to the maximum load of the saw motor. The machine can be furnished with a driving motor suited to any current or voltage. It is made in four sizes, Nos. 1 and 2 not being ordinarily equipped with the hydraulic feed.

Badger Disk-Grinding Machine No. 220 for Leaf-Spring Eyes

The double-spindle, disk-grinding machine shown in the illustration has recently been placed on the market by the Badger Tool Co., Beloit, Wis. It is intended for



BADGER DISK-GRINDING MACHINE NO. 220 EQUIPPED FOR GRINDING EYES OF LEAF SPRINGS

the grinding of parallel surfaces, being shown equipped for grinding the eyes of leaf springs.

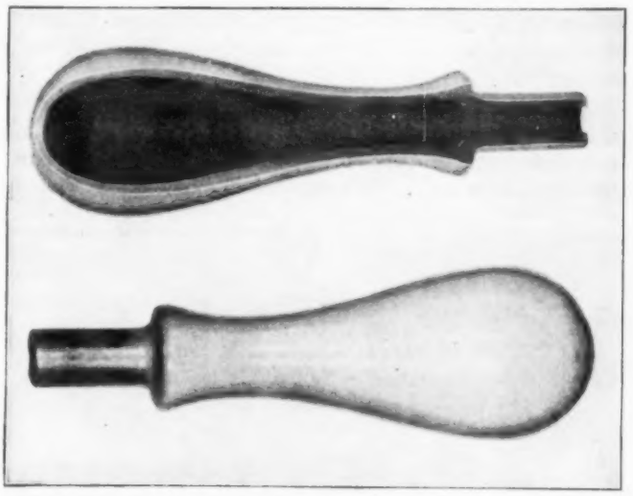
The machine can be furnished with belt drive, but is here shown completely motor driven, each spindle being equipped with a built-in, fully inclosed, 5-hp. motor. The motors slide on ways and drive 16-in. cylinder wheels held in chucks. A ½-hp. motor drives the coolant pump in the rear of the machine. The weight of the machine equipped for spring grinding is 3,800 lb.

When grinding the eyes of springs to length, the attachment shown is used. It consists of a support carrying a sliding carriage to which motion is imparted by means of a rack and a pinion driven by a crank. The eye of the spring rests in a V-block, while adjustable lugs locate the spring and a quick-acting clamp secures it in position.

The two grinding wheels are brought up to stops, and the spring passed back and forth between them. By means of hoods and drip pans the coolant is retained and collected, so that it can be returned to the tank in the rear of the machine.

Rockwood Hollow Pressed Steel Machine Handle

The Rockwood Sprinkler Co., 34 Harlow St., Worcester, Mass., has placed on the market the hollow handle shown in the illustration. The handle is of pressed steel, made by a special process and combines lightness of weight with ample strength to resist any

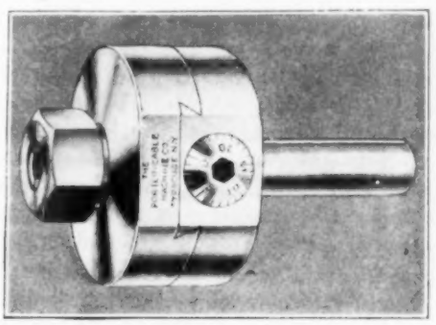


ROCKWOOD HOLLOW PRESSED STEEL MACHINE HANDLE

strain to which such a part might legitimately claimed to be subjected. The handles are made in ten sizes and are especially suitable for the operating levers and handwheels of machine tools and similar machinery.

Porter-Cable "Micro-Adjustable" Boring Head

The illustration shows a boring head recently placed on the market by the Porter-Cable Machine Co., Syracuse, N. Y. The body of the head is provided with a ½-in. shank. To it is gibbed the cross-slide, controlled by an adjusting screw, the head of which is graduated to read in thousandths of an inch. The micro-adjusting screw is at all times entirely enclosed and protected from chips and dirt. It is stated that, because of the ample length of the bearings and the construction of the nut, it is impossible for the screw to bend or bind.



PORTER-CABLE "MICRO-ADJUSTABLE" BORING HEAD

The boring tools are held in a ¼-in. draw-in chuck on the cross-slide, thus providing a simple means of changing them. On account of the adjustability it is possible to utilize tools having long lips.

DuBrul Elected General Manager of the National Machine Tool Builders' Association

Ernest F. DuBrul has just been elected general manager of the National Machine Tool Builders' Association, and for the present the headquarters of the Association will be at 817-818 Provident Bank Building, Cincinnati, Ohio.

He started active work in connection with his new office on Jan. 1, 1921.

Mr. DuBrul was born at Cincinnati, Ohio, in 1873, and received his college education at the Notre Dame University, graduating later in Economics at Johns Hopkins University. His business experience was as

ERNEST F. DuBRUL

secretary, vice-president and later president of the Miller, DuBrul & Peters Manufacturing Co., makers of cigarette machinery; also president of the Pyro Clay Products Co., manufacturers of firebrick.

In civic and association work Mr. DuBrul was very active, having served on the Board of the Ohio Mechanics Institute, University of Cincinnati, and the Cincinnati Business Men's Club. He had active service on many committees of the Cincinnati Chamber of Commerce, National Association of Manufacturers and the Refractories Manufacturers' Association. For quite a number of years he was also the commissioner of the National Metal Trades Association.

During the war he was engaged in all of the Liberty Loan and Red Cross campaigns, having also supervision of the southern Ohio district for the training service of the Department of Labor.

Mr. DuBrul has traveled extensively throughout quite a portion of the world, and is a student of all the questions which relate to the development of modern business.

He is an associate member of the American Society of Mechanical Engineers.

British Scientific Societies' Committee Reports Against Compulsory Metrics

The report of the metric committee appointed by the conjoint board of [British] scientific societies to consider the advisability of the compulsory adoption of the metric system in Great Britain was recently made. The co-operating societies are forty-nine in number and include every conceivable interest in science, engineering and manufacturing.

The report is said to be the most comprehensive that has been made. It is comprised in a pamphlet of seventy pages, from which we can give but a few extracts. These, however, we will preface with a quotation from a French correspondent of the committee—M. Lallemand—"than whom," in the words of the committee, "there is no more ardent defender of the metric system." M. Lallemand says: "This is a very delicate matter and one which requires a very long transition period. For us, after a century, this period is not yet closed."

The following comes after the official admission of the French minister of commerce, industry and labor: "I do not consider it worth while to enumerate here the industries and professions which have continued to employ the proscribed standards, but they are still numerous."

These two quotations are an admission of the failure of the metric system to supplant old units in France; they show that country to be still confronted with the confusion of a dual system, and they demonstrate the ignorance of those who believe the change to be easy and represent it as complete in France.

Below are extracts from the report of the committee:

These are instances of recognition by the most ardent decimalists that a decimal division of units is not universally acceptable.

Nothing can get over the immense disadvantage that 10 has only the factors 5 and 2; whereas 12 has 6, 4, 3 and 2.

And, generally speaking, since a very large number of gradations is not usually required, a decimal subdivision of the habitual unit is not often wanted.

For such small trade a binary subdivision of units of measure, as with the avoirdupois pound, and a duodecimal division of the small coinage, as with the shilling and penny, gives the greater flexibility over the very limited range of common operations.

We may conclude that the compulsory adoption of the metric system in Great Britain would not be likely to have the beneficial influence on elementary education that its advocates have claimed for it.

There is no such confusion in British weights and measures.

This is particularly necessary in view of the fact that a country is often labeled as metric on rather slight grounds. Of a state in Central America a British consul reported that the introduction of the metric system created no public difficulty because no one took the slightest notice of it!

Your committee has not been able to obtain any evidence that a change to the metric system in textile manufactures would be of advantage in the process of manufacture.

It would appear that the continuing necessity for additions to and renewals of existing plants must make it impossible for many years to come to insist on the exclusive use of metric units by this [the engineering] trade even should this country generally adopt the metric system.

The deputy warden of the standards has estimated that the cost of new weights and measures for use in retail trade in this country would amount to about two million pounds.

The advocates of the change assert with confidence that there would be, eventually, an enormous saving of time owing to the simplicity of the metric system, but it is noteworthy that no figures seem to have been put forward to substantiate this claim.

Many are attracted by the superficial advantages of the metric system and do not realize the difficulties of a change, especially in retail trade, where a dual system would be impossible and where there does not seem to be any serious desire for a change.

It is by no means clear that any saving in working expenses effected by the adoption of the metric system would not be gained equally by the decimalization of work in British industries, such as has already been adopted in the highly specialized mechanical and textile industries.

To insist upon the replacement of all gas meters within a limited term of years in order that producers and consumers may have the purely theoretical advantage of dealing in cubic meters or liters, instead of in cubic feet or gallons, would, in the opinion of this committee, be absolutely wasteful.

The habit of quoting prices fractionally [in American stock exchanges] seems to be an example of the real advantages of binary as opposed to decimal subdivision.

It does not, moreover, appear to the committee that a good case has been made out for any marked superiority of the metric measures for the purpose of carrying on the ordinary trade of the country.

That the kilogram is not in itself a convenient unit is shown by the preponderating use of the half-kilogram under various names for the small shopping in metric countries. That a purely decimal subdivision of units is not convenient in small trade is equally shown by the habitual division of this half kilogram into halves.

Whatever changes in our system are made it is inevitable that the old sizes and fits should be perpetuated almost indefinitely; moreover, no device of specifying them in the awkward equivalents of new units, or of numbering them in sizes and gages, would be likely to prevent the survival of the old units in common use and parlance.

To require that a so-called three-quarter-inch garden-hose must not, after a certain date be so described, but that it must always be spoken of as a ninteen-millimeter hose seems to be contrary to the principles of sensible reform.

The difficulties which would be introduced into the professions of architecture and civil engineering by a sudden insistence on the metric system are probably greater than those in mechanical engineering.

Finally, to cap the climax, we have the following: *No minority report has been presented because there is no minority on the committee which desires to present a separate report.*

What to Do About Inventories

New Government Tax Ruling That Helps—Balancing the Inventory—What to Do With Valuable Workmen—Use Low Rate Machines to Reduce Overhead

By W. R. BASSET
Miller, Franklin, Basset & Co.

THE formula for business success, "Buy cheap and sell dear," is infallible and delightfully easy to follow when commodity prices are rising. It requires some elaboration and modification when, inadvertently, the manufacturer finds his store rooms full of materials which were bought dear, and which must be sold cheap. Under present conditions there is but one way, that I know, for a manufacturer to make money and that is to "Buy little and sell quick."

Unfortunately that advice is of no value to the man with a big inventory of raw materials, goods in process or finished parts. The best he can do is to take steps to lose as little as possible and to get some consolation from the fact that the size of this year's profits tax won't be a subject to cause him much worry.

That by the way, is a place where the factory owner who faces heavy losses on his inventory can see a gleam of light. For the Government has recently made a tax ruling which offers some relief.

The earlier tax regulations were that for tax purposes inventories should be taken at cost. Then in December, 1917, there was a decision permitting the manufacturer to choose one of two bases. One was to value his inventory at cost. The other basis was that dictated by conservative business practice, which is, cost or market, whichever is lower. Few tax payers it seems, made this change, partly because cost was, as a rule, the lower, and the advantage of the change was not obvious, and partly because the knowledge of the ruling did not get to the public generally in time to let them make the change, had they known of it.

The recent decision allows the tax payer, who has for tax purposes, been pricing his inventories at cost to apply for permission to change to the "cost or market, whichever is lower." The permission to change will be granted where the tax payer can show that the market at the close of 1918 and 1919 was above cost, and that prior to this year he had no real choice. But he must adhere consistently to the new practice in the future.

If, however, it appears that there was an opportunity to take a figure lower than cost because market was lower than cost at the close of 1918 or 1919, the change cannot be made because it will be assumed that there has been a real election to continue upon a cost basis.

This ruling offers many manufacturers the chance to write off the heavy loss on inventories which they have actually sustained. It does not, of course, make the losses exactly acceptable, but it eases matters somewhat not to have to pay taxes on a paper profit which is actually a money loss.

But the manufacturer will get more poignant ecstasy, I realize, if he can learn how to reduce the money loss on his inventory. Fortunately, there are several safeguards which have general application, one or more of which every manufacturer should be able to use with money saving effect. The first rule is, "Get your inventory in balance." That is a profitable rule to follow at all times, for it cuts down the working capital needed and even in normally stable markets, lessens the losses that often come from manufactured parts becoming obsolete. A perpetual inventory record which is carefully checked and which shows maximum and minimum quantities for all parts and materials is the first step toward getting in balance. Without such a record, balance is out of the question.

Inventories out of balance are, I believe, the commonest of management "soft spots." I find the trouble in nearly every plant. What good can it possibly do to have on hand enough of one kind of material to last

three months and only a two weeks' supply of another? If two weeks' supply is sufficient, then why tie up so much money? Of course, I realize that a while back deliveries of some items were hard to get and to be on the safe side, it was advisable to order ahead. No one would criticise that; what I object to is getting the habit and continuing such a dangerous practice in normal times. I even have a certain amount of indulgence for the man, who in a rising market, buys far ahead to make a profit. That is commonly accepted to be "good business judgment," although a brutal realist might call it gambling.

Profits Should Come From Manufacturing

I believe that the source of a manufacturer's profits should properly be from manufacturing—not from speculation. Certainly the unbalanced inventories which are now causing losses are the result of unwise buying for a rise.

But often the lack of balance comes from ignorance of what to buy and when. Balanced buying can only come when the shop is able to plan production based on an accurate estimate of what the sales force can sell. I have described the methods of planning production in a series of articles called "Modern Production Methods" which have appeared in the *American Machinist*.

Briefly, the shop should plan to turn out a predetermined number of machines a week. Knowing just what parts go into the assembly and how long it takes to process each part, it can specify to the purchasing agent the amounts of each kind of material which should be delivered each week. That will prevent over buying. To take care of emergencies, it is, of course, well to carry a stock of raw materials and purchased parts. Maximum and minimum quantities can be set for each, depending upon the reliability and promptness of the supplier, the state of transportation and seasonal needs.

Having set maximum and minimum quantities, do not assume that they are set for ever. They should be reviewed from time to time, for conditions affecting them change. Often it is possible to reduce previously set minimums materially. Such a system of inventory control does not take excessive clerical help to handle. The loss which has accrued in the past few months on a single overstocked item, would likely pay for the cost of installing and maintaining the system for years.

Most machine shops are taking a physical inventory now. Let the executives go over each item carefully and consider the amount on hand in the light of its relation to the amount of others. Let them consider the probable needs of the shop as determined by the sales department's estimate of sales. Let them, if they can, do no guessing as to the future of the market.

Then, on a manufacturing rather than on a speculative basis, let them set high and low limits for the amount to be carried. That will safeguard their future and prevent the danger of immediate over buying, with its consequent gambling risk and tying up of hard-to-get money.

But, of course, these are merely precautions against future over buying. They do not offer immediate relief for the present; and it is right now that losses are being taken. Unfortunately I know of no way to make a profit in a falling market on expensive materials now on hand. But careful judgment indicates a few ways in which the losses can be lessened.

The first thought of the man who is caught in a falling market with large stocks of raw materials, is to sell his raw materials and let some one else hold the bag. Unfortunately that is a procedure which is not open to all for it is only the more staple forms of raw materials such as pig iron and bar stock that can be readily disposed of in this fashion.

And it would be distinctly out of my field to make such a recommendation for it would presuppose that I was able surely to prophesy the future trend of iron and steel products. To sell raw materials in expectation of a decline in price is just as much gambling as to buy heavily in hope of a rise. If, however, a manufacturer has an unduly large inventory of staple raw materials and can find a buyer, it might be good business to reduce his inventories in order to improve his cash position.

As I have said, this drastic method of reducing inventory losses is not always possible. There remain other ways to use up the inventory with a minimum of loss, which tie in rather closely with other management problems.

Take for instance the matter of holding the key men of the organization on the pay roll, when orders for the finished product are non-existent and it seems necessary to shut up shop tight. Being reasonably sure that in a few months at the most, business will be normal, no one wants to have to start in with a brand new force. Many of your employees are of course, merely "hands" who can be replaced. But there are a few highly skilled mechanics, such for instance as gear cutters who would be hard to replace and whom you would like to hold.

The first thought of the executive is to use these high-grade men on repairs to machines and plants. It will pay to look over all belting and machines and see that everything is in tip top shape. Very likely there are rearrangements of machines which would speed up production and lessen the travel of goods in process. You did not care to make these changes when you were rushed with orders because of the interruption which they would have caused to production. Now is a good time to make them. I recently visited the plant of a manufacturer of automotive equipment and there saw several high priced gear men cheerfully doing the work of "hunkies" in moving machines. Incidentally, a surprising order had gone out from the head of the business to the foremen in charge of the repair and maintenance work, not to rush the work. Of course, the workmen were not told of this, but the foreman winked at soldiering and did not push the men, for it was better to have the work cost more than necessary than to have to lay off irreplaceable mechanics.

Good Business in Spare Parts

This same concern, although it has not a single order on its books for machines, is doing a considerable amount of manufacturing. The executives several months ago made a careful analysis of the orders for repair parts which had come in from purchasers of its product in the past two years. They decided, and it has proved rightly, that there would be more likelihood of selling customers repair parts than new machines. So they have kept a number of machines and men busy all through the slump, piling up these parts. And they are selling some every day, thus getting in a little real money. When the present slump is over they will probably not have to make any more repair parts for some time, which will be an advantage when they get back onto their regular production. For their plant is balanced, as to machine equipment, to make complete as-

semblies, and when running on regular output, orders for repair parts are bound to cause a great deal of disorganization and upset to the regular production. Furthermore, when urgent orders for repair parts must be sandwiched into the regular production they cost much more because expensive machine set-ups which might have stood for weeks must be broken down and special set-ups made to take care of a few repair parts.

When the machine shop has been put into good condition and enough repair parts put into stock to take care of several months' need, it may become necessary, in order to hold the nucleus of the organization, to make some finished machine parts to stock. Good judgment can be used in choosing which parts to make so that a minimum of loss may be sustained.

The first consideration is to remember that certain raw materials are more saleable in a pinch than others. Pig iron and bar stock, for example, can nearly always be sold in an emergency for some price. Special castings and forgings are, however, practically unsaleable except as parts of a finished product. Therefore, the wise manager will aim to conserve his stock of readily marketable raw materials, and if he must, work up those special castings and forgings which he has already on hand—not of course, buying more except under unusual conditions.

When the finished parts reach the stockroom they will represent money tied up as material cost, labor cost, and overhead expense. Now, as the whole purpose is to give some of his labor employment, it is apparent that we want to put into the finished stockroom just as much labor cost as possible, tied up to just as little as possible material cost and overhead. Therefore, those parts should be made which are intricate and require a large amount of machining in proportion to the amount of material used. By confining the work to small, highly priced parts, and avoiding the heavy parts such as machine beds and so on, we also cut down the cost of handling the work between operations and are able to lay off a large number of non-productive truckers.

Overhead on Parts

The next point to watch is the amount of overhead expense which we are running up on the parts. Therefore, it is advisable to choose parts which can be done on machines carrying low hourly rates. It may even be well to consider using a tool with a low rate even though a higher rate tool is better adapted to the work.

If these suggestions as to choosing parts of low material cost and high labor cost are followed and the work is done on machine tools with a low hourly rate for overhead, we may find that we have a cost story like this: 1,000 pieces—material cost $200—labor cost $1,500, overhead $1,500. Whereas if we had not chosen the parts carefully we might readily have had for the same labor activity: 1,000 pieces—material cost $1,000, labor cost $1,500, overhead $2,300.

It may be objected that by confining the effort to making a few selected parts we are getting the finished stock inventory badly out of balance. That may seem inconsistent with the emphasis I earlier laid upon need for balance. There I had principally in mind raw materials, although normally all stock should be kept in balance.

My only defense is that I do not believe that any rule governing any phase of management can safely be considered too sacred to break when conditions demand it. It remains true that the inventory which is consistently kept in balance in normal times is a safeguard against excessive loss from obsolescence and a falling market and enables the manufacturer to save considerable sums of money in interest and also in carrying charges.

Summing Up

Let us now briefly sum up the steps which the manufacturer can take to reduce his inventory losses at this time:

1. If he has been taking inventory at cost he can probably get permission from the Government to take cost or market whichever is lower.
2. Get raw material inventory in balance.
3. Set maximum limits for each item to prevent undue buying at this or any future time.
4. Buying should be governed by the needs of the shop.
5. If key men are to be held, put them first at repairing the shop and equipment.
6. If they must be used to manufacture, turn out repair parts.
7. Work up special raw materials like forgings rather than staples like bar stock.
8. Make parts in which the proportion of labor cost to material cost is high.
9. Keep overhead down by using machines having a low hourly rate.

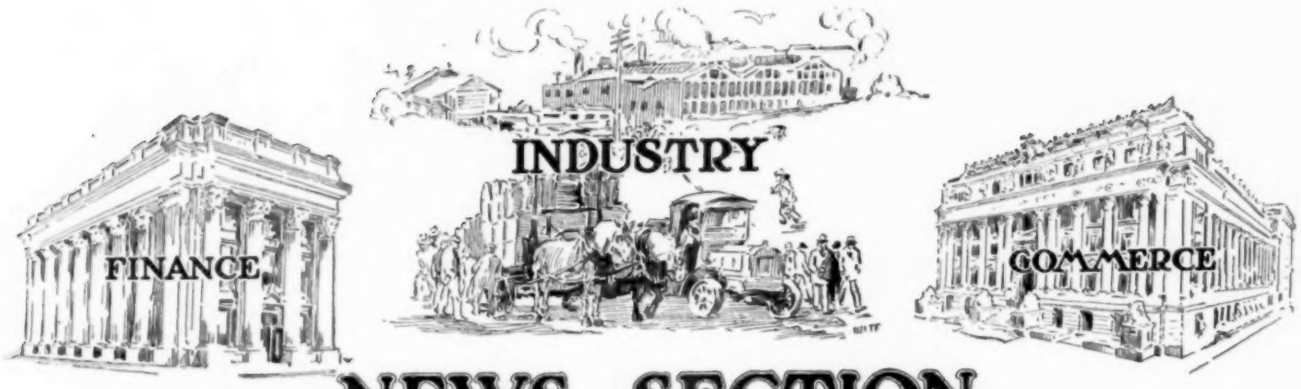
High-Temperature Treatment of High-Speed Steel

"The Relation of the High-Temperature Treatment of High-Speed Steel to Secondary Hardening and Red Hardness," is the subject of Scientific Paper No. 395, recently published by the Bureau of Standards, Washington, D. C. It was written by Howard Scott, assistant physicist. The paper deals with the results of the study of microstructure, hardness, density, magnetic properties and thermal characteristics of a typical high-speed steel as affected by various heat treatments.

For hardening, the specimens were placed in an electrically heated alundum-tube furnace in which charcoal or illuminating gas was burned to prevent excessive oxidation. Light mineral oil was used as the quenching medium. When cracking occurred, the cracks generally followed the contour of the specimen, indicating that they were characteristic of the steel and not due to inclusions.

The following conclusions were drawn from the data derived in the experiment:

1. A high-speed steel susceptible to secondary hardening is partially austenitic when quenched from a temperature high enough to produce this phenomenon.
2. The microstructure of high-speed steels hardened and tempered above 200 deg. C. is similar to that of carbon steels, although the same nomenclature in certain cases is not permissible.
3. The behavior of the physical properties of high-speed steel on heat treatment is analogous to that of hyper-eutectoid carbon steel.
4. The following reasons are given for the use of the high heat treatment: (a) Increase of red hardness; (b) increase of initial hardness; and (c) reduction of brittleness.
5. High-speed steel should preferably be tempered for secondary hardness.



NEWS SECTION

Railroad Situation of 1920

Thomas DeWitt Cuyler, Chairman of the Association of Railway Executives, Reviews the Year's Railroad Situation

This is the record year of American railroad operation. Not only has a larger gross tonnage been moved than ever before, but new records have been established in the amount of transportation got out of each car. Even during the war year of 1918 the highest performance was 494 ton miles per car per day, while for August, 1920, the average was 557, and for September and October, 565.

In the nine full months since the Government turned back the railroads to their owners on March 1 the railroad companies under private operation have:

1. Increased the average movement per freight car per day 6.3 miles—from 22.3 to 28.6 miles.
2. Increased the average load per car 1.7 tons—from 28.3 to 30 tons.
3. Made substantial reduction in the number of unserviceable locomotives.
4. Reduced the accumulation of loaded but unmoved freight cars from 103,237 on March 1, to 21,991 on Dec. 3, of which only 6,386 were detained because of the inability of the railroads to move them.
5. Relocated approximately 180,000 box cars from the East to the West for the movement of farm produce.
6. Relocated approximately 180,000 open-top cars from the West to the East to keep up the production of coal.
7. Moved the third highest coal production in the history of the country.
8. Spent over $500,000,000 extra on improving the maintenance of tracks, bridges, cars and locomotives.
9. Contracted to spend about $250,000,000, largely out of earnings, for additions and betterments to promote the movement of cars.
10. Made arrangements to purchase approximately 50,000 new freight cars, 1,500 new locomotives, and 1,000 new passenger cars.
11. Begun the reconstruction of thousands of old cars.
12. Moved—with a deteriorated plant, under disturbed labor and business conditions—the largest volume of traffic ever known in a single year, with the highest efficiency yet achieved, and with a minimum addition to the value of the property on which the public has to pay a return through rates.

When the railroad companies resumed operation of their properties on March 1 an unusually large number of cars and locomotives were in bad order; the stress of war conditions had compelled their use in a most intensive manner, and the time was at hand when much of the rolling stock was due for thorough repairs; a very small proportion of the cars of any road were on its own lines; equipment was badly distributed with reference to the needs of traffic; there were no stocks of coal left over from the preceding year; a vast amount of grain remained on hand from 1919; and a volume of business was being offered which seemed beyond the ability of the railroads to move.

In addition, railroad labor was in an uneasy and dissatisfied frame of mind. The railroads inherited pending wage demands amounting to approximately $1,180,000,000, and while every effort was made by the railroads to bring the wage questions to a satisfactory conclusion through the U. S. Railroad Labor Board, outlaw strikes developed in April which produced effects wholly disproportionate to the number of men ceasing work.

Commissioner Aitchison's Comment

Interstate Commerce Commissioner Aitchison, who has been in direct charge of car service matters for the Interstate Commerce Commission, has said:

The condition in the spring of 1920 was more menacing to the domestic welfare of the country than it was in the early winter of 1917 when Federal control was assumed. But the situation was met, squarely and courageously in a business-like way, without political interference or pressure of any character whatsoever, under the orderly processes of law, by privately operated railroads, directed along consistent lines to secure the unity of object and policy which was the end sought in placing the carriers under Federal control during the war.

The annual report of the Interstate Commerce Commission filed with Congress on Dec. 9 states:

Comparing August, 1920, with August, 1919, the increased mileage had the effect of increasing the car supply 287,694 cars; the increased tonnage per car had the effect of increasing the car supply approximately 104,942 cars.

The railroad companies have manufactured increased transportation capacity, not out of new cars and locomotives, but out of increased efficiency. If the enlarged capacity provided by the companies during the past nine months had had to be produced by new cars and locomotives it would have required the expenditure of approximately $2,000,000,000, a sum of money which would have been permanently added to the property value of the railroads, on which the public would ultimately have to pay a return through rates.

In avoiding the expenditure of this $2,000,000,000 or any substantial portion of it; in increasing the efficient use of our present facilities; and in restoring the orderly flow of commodities, the railroads have made a great contribution toward bringing about more normal economic conditions, and have fully met their responsibilities in this period of national readjustment.

For this result, however, the railroad companies do not take sole credit. The help of shippers in promptly loading and unloading cars — using Sundays and holidays as well as weekdays—and the day-and-night, rain-or-shine work of hundreds of thousands of railroad employees in placing and removing those cars and in keeping them moving when once loaded, are gratefully appreciated.

It is the earnest hope of the railroad companies that this will be a national object lesson in the value of co-operation and will lead shippers, railroad employees, railroad executives and the general public to pull together for an even better showing in 1921.

Higher Rates Not Expected

The statement is being made in various quarters that the railroads will shortly seek a further increase in rates. I know of no movement on the part of the railroads for a general increase in rates, nor do I expect any. It is true that the railroad companies are not yet receiving from the increased rates anything like the 6 per cent return needed. But the railway executives realize that they are trustees of a great public interest in the reduction of railroad operating expenses to the lowest possible figure, and every effort will be made during the coming year to accomplish this by further economies and efficiency.

Private ownership and operation of railroads as a measure of sound public policy rests largely upon its superior efficiency and economy. In my judgment the American railroad companies during the present year have fully justified, and during the coming year will make every effort to continue to justify, the support and confidence which public opinion in gratifying measure has already accorded them.

Business Conditions as the Big Banks See Them

National Bank of Commerce in New York Sees Change for Better in Business Situation

The controlling and outstanding factor today is the relatively small movement of raw materials and manufactured goods even at reduced prices. This is because stocks of goods in the hands of retailers are sufficient to meet the needs of a somewhat lessened demand of the consuming public. Consumers are restricting their buying in part because of some curtailment of their purchasing power, but even more because of a willingness to wait until retail prices reflect the lower levels of primary prices.

Improvement of business activity awaits adjustment of retail prices to a level satisfactory to the public. It is clear that farmers, for example, who consitute the largest single class of consumers and who have already experienced a substantial reduction in the prices of their products, will not renew their buying on anything other than a hand-to-mouth scale until the price of what they buy bears a closer relation to the price of what they have to sell. This necessary readjustment of prices to consumers is now under way and will be expected to make more rapid progress in the future. Its progress will be hastened by the coming into the market of goods which are already being produced on lower cost levels for labor and material.

Sentiment respecting forward conditions, which until lately had been almost uniformly depressed, is now noticeably improving in many directions. This better feeling does not go to the point of optimism, but there is evident a degree of confidence which was previously lacking, in the ability of commerce and industry to meet the future successfully and to conduct business with reasonable profit.

What is now required is courage and respect for fundamental economic principles. Artifical palliatives which are being urged with a view to obviating the difficulties of the adjustment—particularly proposals involving further inflation and cheapening of credit—must be avoided. Such measures, if adopted, could only result in the impairment of the strength of the credit structure and in prolonging and increasing the difficulties of an adjustment which world-wide conditions have made inevitable.

Money Rates

The peak of commercial borrowing may be said definitely to have passed, and from now on there should be a gradual and moderate reduction in the volume of bank loans. The pressure for funds is already less general. The relaxation is, however, spotty in character, varying with the kind of business, and with the requirements in various sections of the country.

The gradual reduction of credit requirements justifies an expectation of moderate easing of rates. Cross currents in the present complex business situation, however, make it impossible to forecast when this may be realized.

The downward price movement, in progress in the case of a few commodities a year ago, and for all important classes of raw materials for many months past, continued without interruption during the month from Nov. 16 to Dec. 15. Even in a period of generally falling prices the future course of the price of each commodity is to be judged by the supply of and the demand for that commodity. At present every commodity must be considered also in relation to the present world-wide situation, the dominant feature of which is lack of purchasing power in Europe.

The progress of the downward price movement to date can be judged by comparison with the highest price reached during the period of abnormal activity following the armistice. Conditions have changed so greatly since 1914, that a uniform return to the prewar price level does not seem probable. At the same time, comparison of present prices with that level is of value, as a measure of the reclines which have taken place.

It should be specifically noted that the price for the nearest available date to the fifteenth of each month was not necessarily the highest price reached. For purposes of comparison, the price is also shown for Jan. 15, 1914.

Commodity	Unit	Highest price for 15th of any month since armistice or since removal of government control: Date	Highest price: Price	Price on 15th of Dec. 1920	Price on 15th of Jan. 1914
Cattle	$ per 100 lb.	Oct. 1919	16.80	9.50	8.60
Coal—					
Anthracite, buckwheat	$ per ton	Dec. 1920	8.00	8.00	2.25
Anthracite, stove	$ per ton	Dec. 1920	8.00	8.00	4.00
Bituminous, Fairmont	$ per ton	Aug. 1920	12.00	4.00	.85
Bituminous, Pittsburgh	$ per ton	Aug. 1920	11.00	3.75	1.30
Copper	c. per lb.	Aug. 1919	22.50	13.75	14.12½
Corn	$ per bu.	May 1920	2.15	.72	.62½
Cotton	c. per lb.	Apr. 1920	41.50	14.75	12.88
Hides—					
Heavy native steers	c. per lb.	Aug. 1919	52	*	17½
Calfskins	c. per lb.	Aug. 1919	1.00	.15	.21
Hogs	$ per 100 lb.	July 1919	22.10	9.10	8.25
Iron and Steel					
Pig iron	$ per ton	Sept. 1920	48.50	33.00	12.50
Steel billets	$ per ton	July 1920	65.00	†45.00	20.00
Lead	c. per lb.	Mar. 1920	9.37½	4.75	4.10
Petroleum—					
Pennsylvania	$ per bbl.	Dec. 1920	6.10	6.10	2.50
Kansas-Oklahoma	$ per bbl.	Dec. 1920	3.50	3.50	1.03
Rubber—					
Plantation	$ per lb.	Feb. 1919	.56	.17½	.56
Para	$ per lb.	Jan. 1919	.60	.19¼	.73
Silk	$ per lb.	Jan. 1920	16.25	6.20	3.80
Spelter	c. per lb.	Jan. 1920	9.10	5.75	5.10
Sugar	c. per lb.	May 1920	21.57	4.63	3.29
Wheat—					
Spring	$ per bu.	May 1920	3.30	1.61½	.91½
Winter	$ per bu.	May 1920	3.06	2.00	.96½
Wool—					
Ohio fine delaine	$ per lb.	Apr. 1920	2.35	1.12	.56
Ohio ¼ blood	$ per lb.	Aug. 1919	1.20	.45	.39

* Nominal, 20 cents asked.
† Range, $43.50 to $45.00.

National City Bank of Chicago Discusses the Buyers' Strike, Unemployment and Business Honor

The nation is witnessing the most extraordinary buyers' strike ever seen, as the drastic readjustment of merchandise and commodity prices has been brought about primarily by the refusal of the consumer to pay war prices in peace times. The consumer has always been in control of the situation, although he never realized his power until the restriction of credit facilities and the intolerable burden of high living costs made him insist upon thoroughgoing reduction in all lines. This process is putting the country upon a sounder industrial footing and fast eliminating the evils resulting from war time inflation. Average prices have declined in many cases from 25 to 50 per cent below the high level of the war period. This has relieved the credit strain to some extent, although there are still plenty of applicants for nearly every free dollar of credit that the banks have to lend. No one can tell just when the readjustment will be completed, nor what will be the average level for commodities and essential merchandise at that time. Present prices in many cases are still from 50

to 75 per cent above the pre-war level, which, however, no one expects to see restored immediately, if at all. It was fourteen years after the close of the Civil War before the price level of 1861 was restored and economists contend that many years must elapse in this instance before the price level of 1914 can be re-established. Others feel that level can never be restored as production costs the world over are higher and the present scale of living and doing business has changed radically within six years.

It is unfortunate that unemployment is increasing, for in a period of world-wide industrial unrest it is not a good thing to have any considerable portion of the population without anything to do. The indications are that this shifting of labor will go further and that ultimately there will be such a readjustment of wages as shall accord with the new conditions of living and doing business. If it is possible to make the merchandise dollar go further, it is inevitable that sooner or later the wage dollar must purchase more and better service. Should the efficiency of all labor increase in the manner that it has increased in the transportation service, the resultant gain may obviate the necessity of serious wage reductions, for greater efficiency means greater productiveness which is one of the things the country most needs. Workers everywhere are beginning to realize that they must give a better return for the wages received and that the country is facing a condition where there are more workers than jobs. Several important movements have been undertaken to harmonize differences between capital and labor and to secure the kind of co-operation that shall increase the industrial output per unit of worker and make for genuinely better living conditions all around. These negotiations are still in progress and since high experts are concerned in the movement, it is reasonable to expect important developments during the next few months. These reforms would do much to increase national efficiency and promote the welfare of the workers at a time when it is of all things essential to check radicalism and the spread of Bolshevism.

Efforts have been made by some importers to get their banks to refuse payment on irrevocable letters of credit so as to save the American buyers of foreign merchandise from having to take sugar and other commodities purchased abroad several months ago at much higher prices than now prevail. In support of these efforts some importers have set up frivolous claims based upon various pretexts to enable them to violate their contracts. In cases where the seller has lived up to his contract and has kept his part of the agreement, the American buyers ought to pay such claims forthwith. Any other course would cause the greatest confusion and imperil the validity of the irrevocable letter of credit which must be safeguarded at all hazards. An importer can do no greater injury to his country's foreign trade, nor to his own reputation in foreign markets, than to seek to hold up payment of a just debt, because the market went back on him after he had obligated himself to pay a specified price for a certain commodity. An irrevocable letter of credit, if it stands for anything, means instant payment on presentation at maturity. If it is treated in any other way, both the buyer of the goods and the bank that issued the letter of credit are injured irreparably and the American bill is put instantly under suspicion. This issue is clearly defined, for the man who will live up to a bargain only when it is financially advantageous for him to keep his word constitutes a poor normal risk and is a danger to the community. The great London banks on the occasion of the Southern cotton frauds several years ago took losses aggregating several million dollars, paying the claims even after it was known that fraudulent bills of lading had been issued. Victor Murdock, chairman of the Federal Trade Commission, in speaking before the American Specialty Manufacturers Association at Atlantic City the other day said that the first essential factor "entering into confidence in business is inviolability of contract. Our pledge must continue to be our bond if the next few months are not to be a time of even greater difficulties." This is literally true and, fortunately, states the practice of 99 per cent of all right-minded business men.

Steel Business Healthy According to Peoples National Bank of Pittsburgh

December is usually a critical month of the year when inventories are readjusted and final preparations are made for annual settlements. The most prominent feature of the month just closed was the continuation of the downward movement in commodity prices, which has been in progress for more than thirty weeks. Steel was the last of the basic commodities to yield, and while its movement has not gone as far as that in copper, grain, cotton, and wool, it covered much ground in November and December, and 1920 closed with the average price of the chief steel products at the lowest levels of the year.

The steel trade being better organized than some other industries, it has been possible, to some extent, to regulate supply to demand, and at the close of December output was the smallest for many months. Naturally there has been a corresponding reduction in the consumption of coal and coke, and a very decided fall in the prices of these commodities. A noticeable decline in the volume of railroad traffic is also reported in the more important industrial districts, and for the first time, possibly, in more than two years there is idle equipment on some of the roads.

One of the most prominent features of the steel trade during the last quarter of 1920 was the falling off in the amount of unfilled orders on the books of manufacturers. However, the official figures of the Steel Corporation prove that the average monthly increase in orders booked earlier in the year when consumers were convinced that an upward turn had taken place in the industry was larger than the average monthly decrease during the latter part of the year when reaction had set in. It is expected that contracting for delivery during the first quarter of 1921 will appear this month, and if there is an easing in the money market, which is looked for, and if there is a material reduction in labor costs, which is already in progress, an impetus will be given to the steel business.

Already some of the railroads are anticipating their steel rail requirements, and predictions are made that this year will witness a large increase in the steel rail output over previous years.

An encouraging feature of the situation is the manner in which the financial strain of the past month was withstood. There were less adverse consequences than anticipated sixty days ago. While there was an increase in the number of commercial failures during this period, there was none of sufficient magnitude to cause serious disturbance. Credit resources were developed which proved adequate to the occasion.

In the matter of manufactured products the country lives pretty much on a hand-to-mouth basis. In some lines of manufacture there was a material curtailment of output during the last half of 1920. The reaction was not in progress long enough seriously to impair the buying power of consumers, and while a movement described as a "buyer's strike" was witnessed during the past two months, nevertheless considerable inroads must have been made upon stocks of manufactured goods in the hands of retailers. If the expected January reductions are made in retail prices, a revival of buying may be looked for this month, and before supplies can be replenished on a lower-cost basis, the mercantile trade is likely to present a much steadier tone than now appears to be the case.

Review of World Economic Conditions by the National City Bank of New York

The second year following the armistice did not bring the degree of industrial recovery and social recuperation among the peoples of Europe which had been hoped for. Conditions over the greater part of the continent are still in great confusion, and much of it even more distressing than a year ago. There are, however, some signs of progress toward order and better things. The war between Poland and Russia has left deplorable results in the desolation of territory and destitution of great numbers of people, but although there are misgivings in some quarters of

more hostilities on the Russian frontier, for the present peace is established in Europe, except for the trouble that Italy is having with some of her own excessively zealous patriots over the terms of her agreement with Jugoslavia. The consummation of this agreement between the responsible authorities of the two countries may be counted one of the important accomplishments of the year.

Russia

Within Russia the authorities at Moscow now have no armed or organized opposition, and may go ahead in their own way to revive the productive industries of that vast territory. If they can produce a surplus of foodstuffs and of the raw materials which western Europe needs, and deliver them at the coast or any of the country's boundaries, it is not likely that they will be seriously hampered by inability to trade them for the products of other countries. The ambitions of the Bolsheviki to convert the world to their peculiar beliefs will be best served by demonstrating the virtues of their system in practical operations at home.

Austria and the Balkans

Conditions in Austria are desperately bad, due fundamentally to the political severance of Vienna from the territory of which it has been the industrial and commercial, as well as political, center. The immediate problem is to get the population of Vienna through the winter.

Hungary, Rumania, Bulgaria and Jugoslavia are largely agricultural territory and although struggling with treasury deficits, hard times, and insufficient supplies of many kinds have not the more difficult problem of providing for great city populations.

Italy

Italy has quieted her most alarming disorders. The new Labor Board which is to be established will be for the purpose of accomplishing conciliation, but is not revolutionary in character. The treasury is in improved condition as a result of new taxation; the revenues in October are reported as three times those of October, 1919. In the first nine months of 1920 imports decreased 576,000,000 lire and exports increased 1,762,000,000. The note circulation of the Bank of Italy on Oct. 10 was 15,238,000,000 lire, against 14,445,000,000 a year before, and 1,556,000,000 in 1914. With the increased revenues this inflation should cease.

Poland

Poland has been prostrated by the struggle with Russia. The industrial and financial situation is very bad, with the currency depreciated almost to the vanishing point by the enormous issues of the past year. Although the country is normally more than self-supporting in food production it requires importations this year, and needs help to cope with epidemics of disease both among the people and farm animals. Although united in antagonism to Russian bolshevism the people are very much inclined to socialism, and their experiments in the state management of industries have added enormously to the confusion and distress. In a recent lecture at Warsaw Professor Globinski, an economist of standing, stated that the country had 410,000 civil officials and that including the army the burdens of government were overwhelming. He said that the state railways have five times as many employees per kilometer as the roads of western Europe. The change of the land laws at this time is not conducive to increased production.

Czecho-Slovakia

In Czecho-Slovakia the Minister of Finance has recently promised that the budget for the ensuing year will balance, although it is not altogether encouraging that the principal burdens are said to be for social and military projects. Socialism is strong here also, and the chief difficulty with which the industries have to contend at this time is the lack of coal, which is aggravated by schemes for the socialization of the coal industry. The mines were gutted during the war and require large expenditures for development, which are held up pending a determination of what shall be done with the industry. Vienna is mainly dependent on these mines and a shortage of coal is the chief drawback of all Europe.

Germany

Germany is still in an unsettled and agitated state. The crops of 1920 were not good, there is need to import food and raw materials but the exports are insufficient to pay for them. The industries are not working at a rate sufficient to provide for even the needs of the German people, to say nothing of paying indemnities. The revenues of the government are far short of what is required to meet its expenditures, and the deficit is met by printing money, which demoralizes the currency and foreign exchanges and aggravates all the disorders. The railroads, all of which have been taken over by the federal government, are running steadily behind and are a heavy burden on the public treasury. A lack of coal hampers the industries, but in this respect there has been some improvement recently—the most hopeful sign of the year.

Overshadowing every other problem in importance is the question of indemnities. Recent proceedings of the Reparation Commission have afforded ground for expectation that the amount of the indemnities will be definitely fixed, and at a sum which will encourage the German people to energetically undertake the task of payment. At present the situation in Germany is very gloomy, and it affects the entire European and world situation.

In Belgium and France substantial progress in industrial recovery has been made. In Belgium production was back on the whole at about pre-war volume before the present depression came on. France has done much in rebuilding the devastated territory and in getting the crippled industries into operation. Her industrial output has increased, and the adverse balance of trade has been largely reduced. The *Temps* of November 22 gave the value of imports for ten months as 29,784,000,000 francs, against 27,397,000,000 in 1919, and exports as 18,890,000,000, against 7,733,000,000. France shows many evidences of progress, convincing to the world and cheering to her own people. Among them may be mentioned the payment of $150,000,000 to the United States. A new internal loan has been floated recently, to which subscriptions, including certain conversion privileges, aggregate 50,000,000,000 francs, and by the aid of this the government has been able to reduce its indebtedness to the Bank of France to such an extent that the note circulation of this institution is lower than it was a year ago. In France also production of coal is increasing.

Great Britain

Great Britain has passed through a strenuous year, with grave disorders in Ireland and almost equally grave labor problems. The former are more acute at the moment, but the latter are more fundamental. The coal strike was an exceedingly threatening menace, involving as it did a challenge to the government and a covert demand for the nationalization of the coal industry. It was settled, however, with the intelligent co-operation of influential labor leaders, and this is the most reassuring sign in the British industrial situation. The representatives of British labor and British socialism who visited Russia during the year, in every noteworthy instance, reported against the adoption of the Soviet policies by British workingmen.

Despite the difficulties in industry, the revenues of the British treasury have more than met expenditures since the beginning of the fiscal year, April 1, 1920, enabling substantial payments to be made upon indebtedness. The government has stated that by the end of the fiscal year all the war subsidies will be abolished. At the close of 1919 the government announced that the outstanding issue of exchequer currency notes, above cash reserves, would not be permitted to exceed £320,600,000 in the year 1920. This pledge has been observed, the excess on Dec. 1 being £303,854,000, and the percentage of reserve 13.5, against 9.1 at the close of 1919. The gold stock of the Bank of England on Dec. 1 was £124,991,291, against £91,790,369 on that date of 1919. During the eleven months to the end of November the adverse balance in foreign trade was reduced about $600,000,000. In actual accomplishments therefore Great Britain has notably improved her situation during the past year.

We have mentioned above only the countries of Europe which were in-

volved in the war. They all suffered terrible losses in manhood and capital, and are suffering by the disorganization of their industries. The latter source of loss is due in part to the war, but even more to the agitation which seeks to overthrow the existing social order of things.

The effects of this disorganization of Europe are felt throughout the world. Europe was the center of the world's industrial organization, a great market for the products of all other quarters of the globe. The equilibrium which formerly existed in the world's industries is disturbed by the inability of Europe to trade as formerly. The people need clothing, but they cannot buy cotton or wool. They need the metals, copper, lead and zinc, but cannot buy them. They would like to have meats but have not the means of payment.

The spurt of activity which followed the armistice could not be sustained, and has been succeeded by a state of depression in all countries. A cable dispatch from Geneva, Switzerland, the seat of the League of Nations, dated Dec. 22, says:

"From every part of Europe, from old countries and new, and even from Asia, reports arrive of unrest and disturbance, of commercial crises, unemployment and inability to sell products, together with the greatest need of such products."

Lloyd George on the Situation

The Premier of Great Britain, Lloyd George, in a public address recently described the situation as follows, in part:

"Now the first thing we have got to get into our minds is this: The causes are not peculiar to our country. They are something that affects the whole world. It is not an atmospheric depression that affects one degree, one coast, one country; it girdles the earth—the United States of America, Japan, China, India, France, Italy, Germany, as well as the United Kingdom. The whole world is suffering from it. Now it is important when you come to think of remedies to get that fundamental fact into your minds—(hear, hear)—so that we should not run into remedies that may be applicable to one country and not to another.

"For instance, countries with totally different economic systems are suffering alike—protectionist countries, free trade countries, countries with good governments and with bad governments — (laughter) — countries whose governments, in the eyes of Lord Northcliffe, can do no wrong, and countries whose governments, in his lordship's clear eye, can never do right. (Laughter.) They all suffer alike. It is raining on the just and the unjust without stint. And Socialistic countries are suffering just like those wretched individualists are suffering. The working classes are more wretched where the sun of liberty is shining upon them under the ægis of Lenine and Trotzky than they are in this benighted country, where they are locked up in the dungeons of capitalism.

"I got figures from the Board of Trade this afternoon of what we sold to Europe before the war. We sold from this country, most of it our own products, but we got a profit on even what passed through—we sold 246 millions' worth of goods. At present prices, I am told, that would be about 600 millions, probably more.

Europe Bankrupt

"Where is that trade now? Our customers are impoverished, bankrupt. I am not sure about borrowing. The printing press may save you for a time, but you cannot always carry a sack of paper on your backs. That is what is happening in Europe. They cannot get on without it, and when they buy they cannot pay. Have you ever seen the spectacle of a man in rags, down at heels, standing in front of a shop window looking at clothes and boots of the latest fashions? And you say why does he not buy, he is in rags, he needs them, why does he not go in the shop? He cannot pay.

"Europe is standing in front of our shop windows, stocked with the best goods that any land can turn out. And it is in rags and wants to buy. But its pockets are full of paper. It cannot buy. And until a customer is in a condition to trade with you we must admit it. Do not let us work up pretended causes; let us get at realities. Britain has got to work its way back to a full purse, and until it does that nothing that governments can do, nothing that federations can do, and nothing that newspaper articles can do can help us. (Cheers.)

Peace and Hard Work

"What are the remedies? The first is peace. Europe cannot work its way back to prosperity unless it has peace. Europe must work with both hands. (Applause.) She cannot handle the sword and the trowel. I cannot stand those men who are constantly blowing on the embers of the fire. Stamp out those who are going about with petrol tins to start fresh fires." (Applause.)

That speech might have been made as appropriately in the United States. When the truth it sets forth is comprehended all the people will be in better state of mind to set about repairing their fortunes. The first thing is to know that their misfortunes are not due to a conspiracy among grain speculators, or on the cotton exchange, or in Wall Street. All commodities and all markets are involved, and it cannot be supposed that commodities traded in all over the world could be sustained in price in the United States when they were falling everywhere else.

The Union Bank of Canada is issuing from its New York agency, 49 Wall St., a booklet, entitled "A Canadian Plant—Why?" and giving a concise survey of the opportunities Canada offers the American manufacturer.

Railroads Buying in Large Volume

The greatest factor toward stabilizing the iron and steel industry and helping to bring it out of its present chaotic state is the recent buying movement inaugurated by the railroads upon the announcement by the independent steel mills of a rail price cut to the corporation level of $45 for Bessemer and $47 for open-hearth steel rails. With this announcement the Pennsylvania placed an additional order for 100,000 tons and the New York Central one for 75,000 tons for 1921 delivery, both orders going to the independents and involving over $8,000,000. The mills participating are the Bethlehem Steel Co., the Lackawanna Steel Co. and the Midvale Steel and Ordnance Co. The 100,000-ton order previously placed by the Pennsylvania was allocated between the Carnegie Steel Co., and the Illinois Steel Co. The Boston & Maine and Maine Central lines placed orders aggregating over 15,000 tons. At present railroads are being refinanced on a scale never before attempted and heavy buying is expected to take place to fill the accumulated needs of the past few years. The entire rail capacity of the leading interest is booked for the whole of 1921, with the exception of the Birmingham subsidiary, which is booked over the first half only. Thus it will be seen that the all too lean order books of the independents will directly benefit by the orders now pending. Rail orders placed to date for next year's rolling total over 3,000,000 tons, while over 40,000 freight cars have been ordered, and it is expected that contracts for 20,000 more will be entered into shortly. The equipment purchases of the railroads absorb over 30 per cent of the steel output of the country normally, so the extent of the influence of this factor cannot be overestimated.

A Voluntary Wage Reduction

Nine thousand employees of the Pullman car shops in Chicago are willing to accept a reduction of 20 per cent in their wages and they have so notified the management, it was learned.

This action on the part of the men was voluntary, company officials said. They had no idea the men were contemplating such a step until a committee of the workers appeared at the executive office with the statement. The cut is suggested, the committee said, in order to allow the company to make lower bids to attract work in order to prevent a layoff of employees.

Wages at the Pullman shops have increased 100 per cent in the past three years. The average wage now is $6.77. In January, 1918, it was $3.75. Employees were taken into the management of the company's affairs last June.

Failure of the Bank of Barcelona, with deposits estimated at $100,000,000, has made a serious impression in London financial circles. The Spanish Government sent a large sum of money to Barcelona.

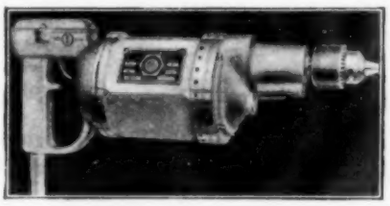
Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

Drill, Portable, Auto-Body Builder's

Black & Decker Manufacturing Co., 661 Liberty St., Baltimore, Md.

"American Machinist," Dec. 9, 1920.

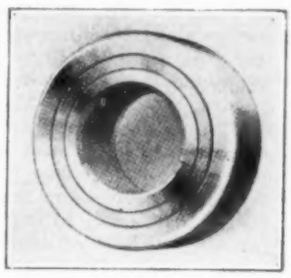


Holes up to ⅝ in. can be drilled by this lightweight drill. Its housing is of aluminum alloy and its gears are hardened steel. The motor develops ¼ hp. and has a no-load speed of 1,480 r. p. m. A pistol-grip handle is furnished, and the control switch is operated by means of a trigger. The drill is equipped with a three-jaw chuck for holding straight-shank drill bits, 15 ft. of duplex electric cable and separable attachment plug. The motor runs on either alternating or direct current and can be supplied for 110, 220, or 32 volts.

Ball Bearing, Self-Adjusting

Langhaar Ball Bearing Co., Aurora, Ind.

"American Machinist," Dec. 9, 1920.

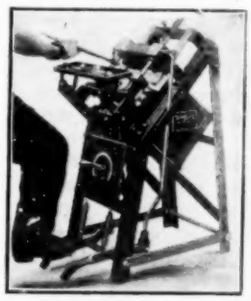


This ball bearing is intended to carry high thrust loads as well as radial loads. The lines of contact of the balls with the races form cones. Spinning and grinding of the balls is said to be largely obviated. The inner race is solid. The outer one is made in two parts. The parts fit together in the manner of jaw clutches, and are fastened by the inserting of pins in holes provided at the joints. The bearing is adaptable to any speed ordinarily used, having proved reliable and satisfactory at speeds as high as 8,000 r.p.m.

Rivet Heater, Electric

Taylor Welder Co., Warren, Ohio

"American Machinist," Dec. 9, 1920.

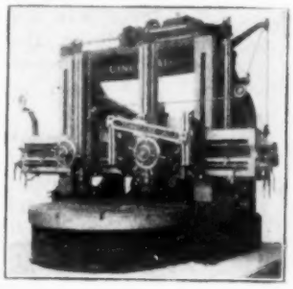


The machine is intended to hold two rivets at a time. A ⅜ x 4-in. rivet is heated in about 30 seconds. A 6 x 16-in. tray is provided at the front of the machine for holding rivets. It is not necessary to actuate a switch for each rivet, as the circuit is automatically closed when the rivet is placed in position for heating. The machine is equipped with a 15-kw. transformer and a five-step regulator for controlling the current, the power consumption being approximately 18 kw.-hr. per 100 lb. of rivets heated. The extreme height of the machine is 40 in., the dies being 32 in. above the floor. The floor space required is 31 x 18 in. and the weight is about 400 lb.

Attachment, Taper for Cincinnati Boring Mills

Cincinnati Planer Co., Cincinnati, Ohio

"American Machinist," Dec. 9, 1920.



The device, shown on an 8-ft. mill, is intended for use on all sizes of boring mill from 42 in. up to 12 ft. The principal parts are a slanting member or sine bar, sine-bar supports and the sine-bar guide fastened to the ram. In order to provide up and down adjustment to the ram, without loosening the sine bar and thereby changing its position, the face of the ram is machined and fitted with a T-slot equal in length to the vertical travel. The power feed to the ram is disengaged by means of the small handwheel, so that the ram is fed vertically by the slanting bar as the head traverses. The use of the attachment is recommended for angles up to 18 deg.

Defectoscope

Durkee Manufacturing Co., Grasmere, S. I., New York

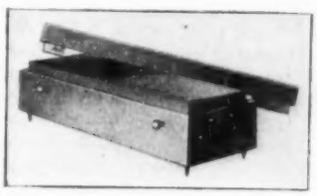
"American Machinist," Dec. 9, 1920.

This device for the testing of steel magnetically is intended for the examination of commercial steel products, being a means of checking the physical uniformity and structure of the work under examination by determining the variation in magnetic homogeneity along the length of the specimen. It is especially adapted for use in locating defects in steel wire, cables, rods, rails and bars. The cut shows a general view of the defectoscope arranged for testing rails. Accurate results are claimed, as the effects of heat treatment and chemical composition upon magnetic properties are known. The process is, of course, not destructive to the specimens under test.

Oilstone Holder, Self-Cleaning

J. A. Raught, 1006 Grand Ave., Racine, Wis.

"American Machinist," Dec. 9, 1920.

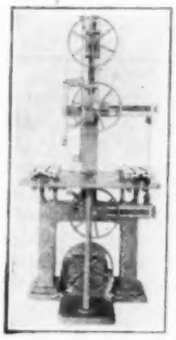


The oilstone holder shown is made of cast aluminum, the surfaces being ground and polished. There are four sharp pegs in the bottom of the holder to prevent it from slipping on the bench. The cover is provided to exclude dirt. The stone rests on four buttons ¼ in. high on the bottom of the holder and is prevented from shaking in the holder by four screws in the sides. The stone lies in a bath of oil, thus keeping one side of it soaked. The holder is made in sizes, to hold stones 1 in. thick, 2 in. wide and either 6, 7 or 8 in. long.

Bandsaw, Metal Cutting

Seattle Machine Works, Inc., 37-51 W. Lander St., Seattle, Wash.

"American Machinist," Dec. 9, 1920.



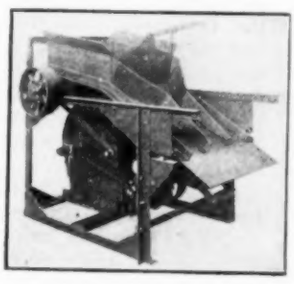
This machine is intended for cutting out solid forged crankshafts, for cutting slots, and for cutting pieces to length. This is accomplished by having the saw cut on both sides of its loop, its motion, of course, being downward on one side and upward on the other.

In order to change the distance between the two cutting portions of the blade, two idlers having horizontal movement are provided, the screws in the slides being connected by means of a chain running on sprockets so that they operate simultaneously. The top wheel is adjusted vertically by means of a hand-wheel, so that the saw can be kept tight for any position of the idlers.

Separator, Chip, Pneumatic

Ideal Concrete Machinery Co., Cincinnati, Ohio

"American Machinist," Dec. 16, 1920.



The separator illustrated is intended chiefly for separating small work, such as screw-machine products, from the chips. The work is placed or discharged into the hopper on the top of the machine, both the hopper and the incline riveted to it being given a compound vibratory motion. When the control gate is opened, the work slides down the incline to an opening. There the blast from the centrifugal blower floats the chips over the opening, while the machined parts drop through into tote pans. The chips continue down the slide and are collected in suitable boxes.

Clip, paste on 3 x 5-in. cards and file as desired

A. S. M. E. Creates Ordnance Section

At a meeting of the council of the American Society of Mechanical Engineers held on Friday, Dec. 10, a petition requesting the formation of an ordnance section of the society was granted, formally establishing this new section along the lines of the other professional sections of the society. The petition for the ordnance section was drawn up at an organization meeting held the preceding afternoon when about thirty men, most of whom were active in the ordnance program of the World War, met in the Engineering Societies Building to put into a definite form the desires of ordnance men and engineers who have had the subject under consideration since 1918.

The chairman of the organization meeting was C. F. Hirshfield, chief of the research department of the Detroit Edison Co., who had been very active in building up this section. A committee of three was appointed by him to nominate officers and to prepare a letter ballot for members to ballot upon officers. The chairman of this committee is Major F. C. Bull, District Claims Board, New York Ordnance District. The other members of the committee are Frederic E. Town, with the Otis Elevator Co., New York, and Ralph G. Macy, construction engineer for Walter Kidde & Co., New York. It was announced that 178 members of the society have already signified their intention of joining the section.

The meeting was thrown open to discussion of what such a section might accomplish. Major Bull interpreted the function of the section as salvaging the knowledge which engineers and manufacturers of ordnance materials had gained in their experience in ordnance production in the War. A number of men present, men who were connected with the ordnance program in one way or another during the war and who are now back in engineering work, related their experiences. Frank B. Gilbreth, president of Frank B. Gilbreth, Inc., Montclair, N. J., was one of those to emphasize the value of making use of the knowledge which these men and many other engineers have gained, applying it to engineering problems and having it ready for any emergency.

Colonel C. L. H. Ruggles, chief of Technical Staff of the Ordnance Department, U. S. A., pointed out that while the Ordnance Department was small and army engineers few in number they were able to handle the technical problems confronting them but needed the support of the engineering societies of the country to secure quantity production.

Colonel James L. Walsh, of Washington, D. C., representing the Army Ordnance Association, offered the co-operation of the Association with its 3,800 members in carrying out any program which the ordnance section may undertake. He urged the closest connection between the two bodies and expressed the opinion that they would work together to attain splendid results.

The general feeling of the meeting was that the new section should be the liaison between technical engineers and manufacturers of ordnance materials, and that it should work toward educating the members of the society and through its members the public as to what are the ordnance requirements in manufacture of ordnance materials and carrying out its program.

American Committee of International Chamber of Commerce Appointed

American participation in the International Chamber of Commerce became fully organized with the appointment of an American committee composed of fifty-seven of the leading business men of the country.

Members of the committee were appointed by Joseph H. Defrees, president of the Chamber of Commerce of the United States. They will take up their work immediately, holding their first meeting in New York on Jan. 6.

The American section is the direct representative of the International Chamber in the United States. It is the point of contact between the membership in this country and the International headquarters in Paris. The American committee will serve in an advisory capacity of the section. In its membership are representatives of the main divisions of the business of the country, chosen with a view of geographical distribution.

The International Chamber was created at Paris last June. In the form of organization adopted each country holding membership has its national bureau as headquarters of its section, its national committee and an administrative commissioner of its own resident at Paris. The American section headquarters began operation in the fall with Lacey C. Zapf as secretary. The American administrative commissioner, Dr. Frederick P. Keppel, has taken up his duties at Paris.

Appointment of the American committee completes the form of organization for this country. Membership of American business organizations, corporations, firms and individuals already has grown to considerable proportions and is increasing steadily.

At its first meeting in New York the committee will take up subjects which the Americans expect to present at the next meeting of the International Chamber in London in June. It will receive a report on this from a special committee consisting of John H. Fahey and Edward A. Filene, of Boston, and Owen D. Young, of New York, all members of the American directorate of the International Chamber. The committee also will consider nominations for American directors for the coming year and will discuss a campaign for obtaining American members.

Automobile Show To Be Held in Mexico in March

Plans for the coming automobile show, which will be held in Mexico City in March, 1921, are progressing rapidly. The secretary of communications and public works has reserved the vacant space in front of the National Theater for this purpose. A temporary structure will be erected, and every distributing agency in Mexico has made arrangements for space in the building.

Acknowledgment of Calendars and Christmas Cards

The *American Machinist* takes this means of acknowledging the receipt of calendars from the following concerns: National Acme Co., American Tool Works Co., Chas. A. Schieren Co. and the New Britain Machine Co. Christmas cards were received from the Norma Co. of America, Black & Decker Manufacturing Co. and R. S. Stokvis & Sons, Inc.

Steel Bookings Said To Be An Optomistic Sign

Declaring that the present business depression is only psychological, Judge Gary, chairman of the United States Steel Corporation, emphasized his point by stating that the daily bookings of the corporation at the present time exceeded the total capacity for its mills at the time of organization. He declared that there was plenty of money in the country and that capitalists are willing to invest in new enterprises just as soon as prices are on "a reasonable, fair and stable basis."

Diesel Engine Used as Dynamo Driver

Members of the San Francisco Chapter of the American Society of Mechanical Engineers last week inspected with great interest the first Diesel engine used to furnish electric power in an office building in San Francisco, when the new power unit in the engine-room of *The Chronicle* building was thrown into operation. The new engine is of the straight Diesel type.

$26,775,000 New York Central Loan Approved

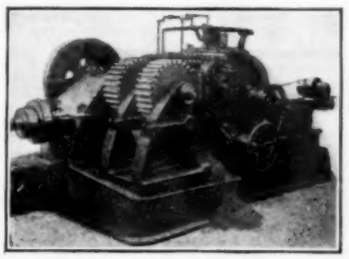
Plans of the New York Central Railroad Co. and a number of its subsidiaries for buying new equipment and making additions and betterments to existing equipment and to way and structures will go forward as the result of the approval on Dec. 23 by the Interstate Commerce Commission of a loan of $26,775,000 to those companies.

Besides the New York Central, the companies which will benefit by the action of the commission are the Michigan Central, the Cleveland, Cincinnati, Chicago & St. Louis, the Cincinnati Northern, the Toledo & Ohio Central, the Zanesville & Western, the Kanawha & Michigan, and the Lake Erie & Western.

Condensed-Clipping Index of Equipment

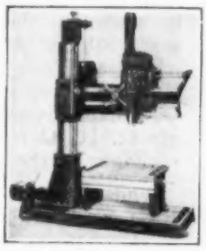
Patented Aug. 20, 1918

Planer, Gear, 48-In., "Sunderland"
J. Parkinson & Son, Shipley, England
"American Machinist" (European Edition), Sept. 11, 1920



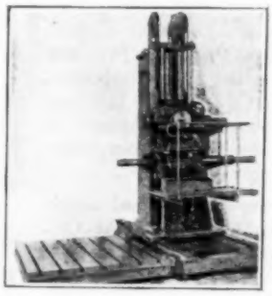
All the Sunderland gear planers for spur and helical gears embody the principle of generation in which the tooth form is developed in the passage of a cutter of rack form in a direction tangential to the pitch circle of the gear being generated, the cutter meanwhile having a reciprocating motion across the face of the gear, during which it acts as a planing tool. This machine will generate gears up to 4 ft. in diameter by 9 in. face and 2 in. circular pitch. It is designed for "double cutting"; that is to say, the machine will operate on two similar blanks mounted on the same arbor.

Drilling Machine, 3-ft. 6-in., Centralized-Control
J. Archdale & Co., Ltd., Birmingham, England
"American Machinist" (European Edition), Sept. 11, 1920



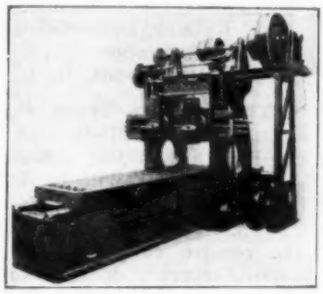
This is a combined sensitive and radial drilling machine. There are nine spindle speeds, from 62 to 760 r.p.m. The drive is by belt. The spindle has a No. 4 Morse taper hole. The spindle is 1⅞ in. in diameter and has a vertical traverse of 12 in. and a horizontal movement of 2 ft. 5 in. The feeds range from 45 to 125 revolutions per inch. The box table is 32 x 27 in., is hinged to the frame and swings clear of the base. The newer features of the machine include a patent saddle and sleeve lock operating simultaneously; thus the arm may be swung and the saddle moved and then both locked with one movement of the lever.

Boring, Drilling and Milling Machine, Horizontal
T. Shanks & Co., Johnstone, England
"American Machinist" (European Edition), Sept. 11, 1920



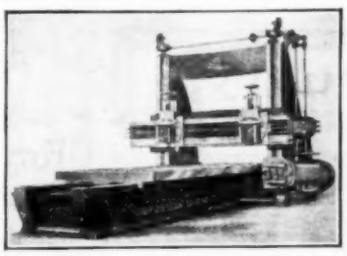
The boring spindle slides vertically on a box-section column, which moves horizontally by rack on a bed. The two slide bars of the bed are set well apart to give stability and the narrow guide obviates binding by cross twist. The main driving motor is mounted on the base of the column and thus travels across the bed with the toolhead. The spindle slide is balanced by weight and has long guiding faces to prevent twisting. The controlling gear introduces several features. First the operator has complete control over the machine movements without moving from the position in which he gets a good view of the work, and, secondly, no two conflicting motions may be put in gear at the same time.

Planer, 8 x 3 x 3-Ft.
Butler Machine Tool, Co., Ltd., Halifax, England
"American Machinist" (European Edition), Sept. 11, 1920



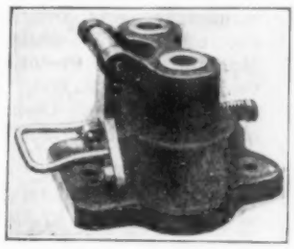
A four-speed countershaft is provided, ball bearings being fitted, and the speed changes are obtained by means of cone pulleys, the belt being lifted from one step to another, a tightening and slackening device enabling the operation to be performed in a few seconds. By this gear a uniform return speed for all speeds of cut is available. To reduce the effect of inertia the reversing pulleys are of aluminum. The drive is by constant-speed motor and belt to the self-contained countershaft. The new features of the machine include an improved cam device for operating the belts.

Planer, High-Speed, Electrically Driven
J. Stirk & Sons, Ltd., Halifax, England
"American Machinist" (European Edition), Sept. 11, 1920



The machine has a 5 x 5 x 16-ft. capacity. The table is 4 ft. 9 in. wide, T-slotted, with troughs at each end for cuttings, etc. Cross-planing can be accomplished by either cross-slide head. The main reversing motor is of 40 hp. at maximum speeds of 500 and 1,000 r.p.m. for cut and return respectively. The table speeds given are from 15 to 240 ft. per minute by means of the gearing in conjunction with the eight-to-one variation of the motor. With the low gear the range is from 15 to 60 ft. per minute cutting, returning at 60 to 120 ft. per minute, these speeds being doubled on the high gear. Weight, 6 tons.

Fixture, Indexing for Milling Machines, Semi-Automatic
B. S. A. Tools, Ltd., Birmingham, England.
"American Machinist" (European Edition), Sept. 11, 1920

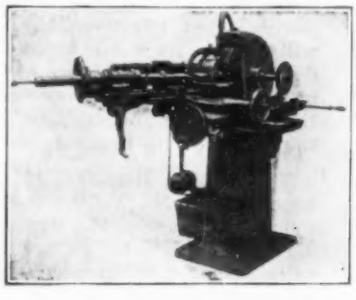


The fixture here illustrated is used for milling hexagons, squares, or any number of flats or saw cuts on small components. It consists of two spindles set side by side on which can be screwed suitable collets or chucks for holding the work. By pulling out the handle in the front of the fixture the operator can index the spindles the required amount, this being controlled by the number of notches in the index wheels, which are mounted at the lower ends of the spindles.

Drilling Machine, Sensitive, High-Speed
B. S. A. Tools, Ltd., Birmingham, England
"American Machinist" (European Edition), Sept. 11, 1920

The chief feature is the method of obtaining the speed range, the main shaft driving the countershaft, by means of three-step cone pulleys, and the countershaft driving the drill spindle. Thus three speeds can be obtained by the movement of a belt-shifting lever, while the complete range of six speeds, from 500 to 2,412 r.p.m., may be obtained by movement of the spindle-driving belt in conjunction with a lever operating a jockey-pulley bracket. The machine has ball bearings throughout. Its capacity is the largest drill admitted by the No. 2 Morse bore in the spindle, namely, a ¾-in. diameter drill. The spindle traverse is 5 in.

Grinding and Point-Thinning Machine, Twist-Drill
W. A. Walber & Co., 38 Victoria St., Westminister, S. W., England
"American Machinist" (European Edition), Sept. 18, 1920.



This machine grinds drills from ¼ in. to 2 in. in diameter, of two-lip form, though by alteration of gearing three- and four-lip drills can be ground. The grinding is automatic. The point-thinning is done by a separate wheel on the main spindle. The machine is self-contained, being driven by fast and loose pulleys. The abrasive wheel carried is 14 in. in diameter by 2 in. by 5 in., and the thinning wheel is 8 in. in diameter by ⅝ in by 1¼ in.

Clip, paste on 3 x 5-in. cards and file as desired

Business Items

A merger has been effected of the American Twist Drill Co. and the Gorham Tool Co., both of Detroit, that will be known as the American Twist Drill and Tool Co. Its capitalization will be increased from $200,000 to $400,000. Heatley Green is president and the active management will be in the hands of L. C. Gorham, formerly general manager of the Gorham Tool Co.

The Chicago Pneumatic Tool Co., New York, announces the resignation of H. L. Dean, formerly manager of the compressor and engine sales division.

The Gilbert & Barker Manufacturing Co., West Springfield, Mass., has announced the following additions to its sales organization: F. E. Mistrot, Waco, Tex.; T. J. Hope, Dallas, Tex.; E. L. Coolbroth, Sr., E. R. Alden, and H. E. Kyburg, Springfield, Mass.; L. K. Draz, Mt. Vernon, N. Y.; and B. L. Heeley, Providence, R. I.

The Calumet Truck Body Corporation, Calumet, Mich., has been organized with $200,000 authorized capital to build what will be known as the Calumet All-Purpose Body for Auto Trucks. The company will be pleased to receive catalogs and prices from manufacturers of malleable and drop-forging parts and fittings used on truck bodies and cabs; also catalogs and prices of tools and shop equipment.

The Bristol Machinery Tool Co., Bristol, Conn., sold its Riverside Ave. plant at auction on Dec. 18. The highest bidder for the plant, except the machinery, was the Wallace Barnes Co. of Bristol, while the Brownell Machine Co. of Providence, R. I., took the latter at $25,000. The plant sale was for $36,500. Owing to conditions of the market the company decided to close out.

Papers filed for record at the office of the town clerk by the G. E. Prentice Manufacturing Co., New Britain, Conn., show an increase in capital stock from $100,000 to $300,000. The notice is signed by G. E. Prentice, A. B. Porter, F. S. Troup and R. C. Legat, a majority of the directors.

The Commercial Camera Co., Providence, R. I., and Rochester, N. Y., announces that effective Jan. 1, 1921, it will change its name to the Photostat Corporation. The purpose of the change in name is simply to more readily identify the name of the company with the name of its products.

The Goulds Manufacturing Co., Seneca Falls, N. Y., manufacturer of pumps, announces the appointment of Edward S. Jenison as acting general sales manager to succeed W. E. Dickey, who retired from business on Jan. 1. Mr. Jenison has been manager of the Philadelphia office for the past five years.

Negotiations are understood to be in progress for the acquisition by the Chelmsford Iron Foundry of the iron and metal yard of A. J. Harris on Tanner St., Lowell, Mass. The purpose is to erect a large foundry on the site in connection with the conduct of an iron and metal yard.

Personals

LEON E. THOMAS, president of the Reading Iron Co., has been elected president of the Eastern Pig Iron Association.

S. DUNCAN BLACK, president of the Black & Decker Manufacturing Co., was recently elected a director of the Automotive Equipment Association.

P. V. BURWELL has been appointed assistant advertising manager of the Black & Decker Manufacturing Co., Baltimore, Md.

ELBERT CLEMENT FISHER, for the past 19 years with Westinghouse, Church, Kerr & Co., Inc., is now connected with Dwight P. Robinson & Co., Inc., with which the former company has become consolidated.

G. A. SCHNEIDER, mechanical engineer with the Standard Steel Car Co., has returned from France and is now located in Chicago.

HERBERT R. CONNOR has discontinued his services with the Phillips Rice Milling Co. and M. Phillips & Co. of San Francisco as chief engineer and has opened an office in San Francisco as consulting mechanical engineer.

Obituary

FREDERICK G. JAHN, inventor of the post-office and bank cancellation machines, died at his home in Brooklyn, N. Y., on Dec. 22. Mr. Jahn was fifty-eight years old.

New Publications

Labor's Crisis. By Sigmund Mendelsohn. One hundred and seventy-one 5 x 7-in. pages, cloth boards. Published by the Macmillan Co., New York.

This volume presents an employer's view of labor problems. It is an analytical treatise of the relations between capital and labor, defining to an appreciable extent their obligations to each other and to the state and offering suggestions toward alleviating the existing unrest of labor. The author's simplicity of style and method of presentation make the book very readable. It is evident that the author has given his subject much thoughtful consideration.

Chapter headings are: Poverty, Its Nature and Effect; Poverty as Related to Labor; Characteristics of Capital and Labor; Labor Not a Commodity; Comparative Value of Physical and Mental Exertion; Depletion and Deterioration of Labor; Labor-Saving Inventions and Labor Supply; the Malthusian Theory as Applied to Labor; Maximum Effort the Foundation of Society; Economic Effect of Curtailed Labor; Can Reduced Hours Advance the Welfare of Labor and Society? Cost of Living Subject to Psychological Influences; Inflated Cost of Living Due to Contraction of Labor; Labor Welfare as Related to Material and Social Welfare; Causes of the Present Labor Ferment; Profit-Sharing as a Basis of Insurance and Pensions; Labor Unrest as a Check Upon Industrial Concentration; Moral Economics as Applied to Labor; Handling of Labor in Small Plants; Labor as it Affects the Wife and the Home; Objections to a Legislated Wage; Housing of the Laborer; Inflation and High Taxes—Their Effect.

The Engineering Draftsman. By E. Rowarth, A. M. I. E. E. Two hundred and forty-five 6 x 9-in. pages, 96 full-page illustrations, cloth cover. Printed in Great Britain at the University Press, Aberdeen, and published in New York by E. P. Dutton & Co., 681 Fifth Avenue.

This book is intended for the use of students already familiar with the elementary principles of mechanical drawing. It provides a course of work corresponding to that of a draftsman during his apprenticeship. Instruction is given by means of illustrations of drawings, explanatory notes being printed below each. In this connection the makeup is very convenient; an illustration appears on the left-hand page and the explanation on the right, both being printed lengthwise on the page so that by turning the book sidewise the former appears over the latter. Sufficient information is given to enable the making of complete working drawings of a steam hammer, hydraulic capstan, hydraulic press, air pump, oil pump, steam-engine governor, lathe, etc. A wide range of the mechanical field is covered.

Export Opportunities

The Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., has inquiries for the agencies of machinery and machine tools. Any information desired regarding these opportunities can be secured from the above address by referring to the number following each item.

A firm in The Netherlands operating a shipbuilding wharf and machine factory desires to obtain the representation of manufacturers of machinery of all kinds, especially boat motors. No reference offered. No. 34222.

A manufacturer in Mexico desires to purchase an 18-inch lathe. Quotations should be given c.i.f. El Paso, Tex. Cash to be paid. Reference. No. 34206.

Forthcoming Meetings

The Society of Automotive Engineers will hold its annual meeting on Jan. 11 to 13 inclusive at New York.

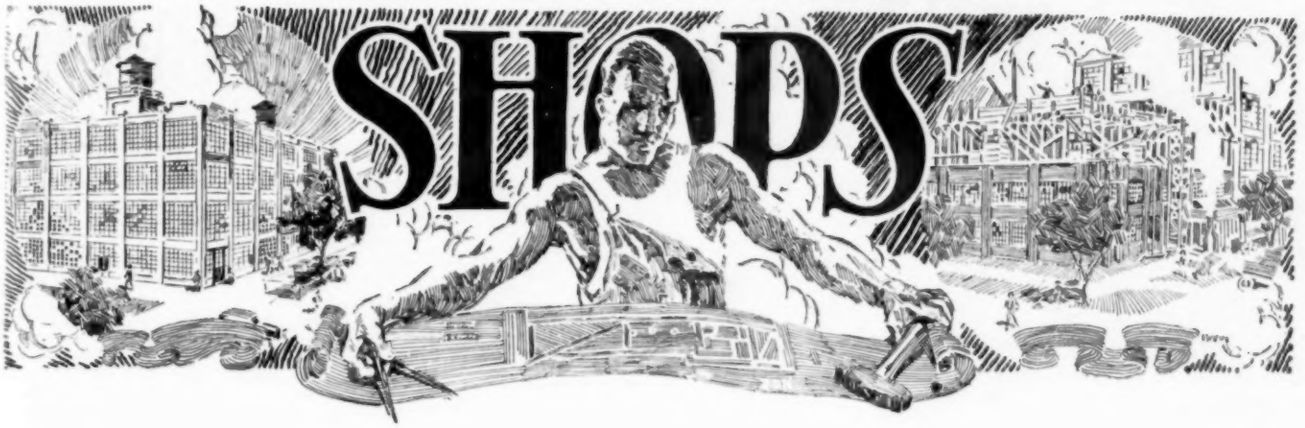
A conference of State Manufacturers' Associations, will be held at the Congress Hotel, Chicago, on Jan. 12. Manufacturers, merchants, railway executives and shippers will attend this meeting to protest against the formation of a national board of adjustment said to be demanded by the railroad brotherhoods. The address of the State Manufacturers' Ass'n is 104 South Michigan Ave., Chicago.

The Engineering Institute of Canada will hold its thirty-fifth annual meeting in Toronto, King Edward Hotel, on Feb. 1, 2 and 3.

A triple convention of the National Supply and Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association will be held in Atlantic City, N. J., May 16, 17 and 18, 1921, with headquarters for all three associations at the Marlborough-Blenheim. F. D. Mitchell, 4106 Woolworth Building, New York, is secretary of the last-named association.

The Spring Convention of the National Machine-Tool Builders' Association will be held on Thursday and Friday, May 19 and 20, at Hotel Traymore, Atlantic City, N. J. Ernest F. Du Brul, care of the Association, Worcester, Mass., is general manager.

NEW *and* ENLARGED



Machine Tools Wanted

If in need of machine tools send us a list for publication in this column

Md., Baltimore—Bowers & Bartlett, Inc., 1201 South Sharp St., manufacturer of washing machines, C. C. Bowes, Purch. Agt.—gears, small bevel and mitre, worm, wheel and die cast; small aluminum die castings; drop forgings, springs, flat and round; malleable and iron castings; forge gears, and steel stampings.

N. Y., New York (Borough of Bronx)—A. C. Chesley Co., 277 Rider Ave.—equipment for the manufacture of metal doors.

N. Y., Rochester—The Alent Machine Tool Co., 467 St. Paul St., N. Alent, Purch. Agt.—second-hand ammunition lathe.

N. Y., Rochester—The Defender Photo Supply Co., Driving Park Ave., M. E. S. Fowler, Ch. Engr.—small lathe and drill press.

N. Y., Rochester—G. C. Humbert, 301 Cornwall Bldg., jeweler, die sinkers engine with flexible shaft.

Va., Richmond—A. S. Kellam, c/o Richmond Pressed Metal Wks., 6th and Stockton Sts.—medium size lathe, (new or used).

Ill., Chicago—H. H. Hanna Corp., 538 South Dearborn St.—
One 8 in. shear 16 gage capacity.
One press 8 ft.-6 ft. between housings, minimum stroke 10 in.
One press 30 in. to 36 in. bolster 8 in. to 10 in. capacity.
One power brake, same type as Collins 4 ft. 16 in., 16 gage capacity.

Ill., Chicago—G. C. M. Products Co., 3153 Chattanooga Ave.—one power shear 36 in. or larger, (new or used).

Mich., Charlotte—The Hancock Mfg. Co., manufacturer of lubricators—one 250-350-ton embossing press (used, in first class condition).

Mich., Detroit—The Modern Pattern & Machine Co., 123 Monroe Ave.—pattern making equipment, including a 3 x 3 x 7 ft. coke burning core oven.

Mich., Detroit—The Zenith Fdry Co., Miller Ave.—foundry equipment.

O., Cleveland—The Natl. Car Wheel Co., 2120 West 106th St.—24 in. to 36 in. radial drill, (used).

O., Mansfield—The Ideal Electric & Mfg. Co., 153 East 5th St.—several new machine tools.

O., Newark—The Oakoal Co., J. Tracy, Mgr.—tool room equipment.

Wis., Racine—The Western Electric Co.—
1 Kearney & Trecker plain No. 1-B horizontal milling machine.
1 Punch press, straight sided and tie rod construction No. 62 V. & O. or 74½ Bliss.
1 18-in. double disc. grinder.

Wis., Two Rivers—Langer Bros.—garage repair machinery.

Wis., West Allis (Milwaukee P. O.)—The Kearney & Trecker Co., manufacturers of milling machines—1 second-hand horizontal boring, drilling and milling machine with about 6 ft. horizontal and 4 ft. vertical travel.

Minn., Minneapolis—The Spyco Smelting & Refining Co., 307 Syndicate Bldg.—disk machine and shell machines.

Mo., St. Louis—The Eagle Picher Lead Co., Benoist Bldg.—1 second hand 2½ ft. radial drill.

Cal., Los Angeles—The Catholic Bishop of Monterey and Los Angeles, Higgins Bldg.—garage machinery, lathes, drills, etc. Estimated cost, $3,000.

Machinery Wanted

Mass., Boston—The Boston Herald, Tremont St.—new presses, linotype and rotogravure machines.

Mass., West Bridgewater—The West Bridegwater Fdry.—molding machines, sand blast, etc.

Md., Baltimore—The Duraflex Co., 409 Continental Bldg., manufacturers of flooring, etc., J. E. Nachod, Purch. Agt.—

1 rotary or pan type drier, direct fire capacity 500 lb. asbestos fibre per charge, (used).

1 hand or electric operated hoist to run on overhead rail, 1,000 lb. capacity, (used).

30 in. Buhr or Esopus stone water cooled paint mixers and grinders, mixer equipped with agitator blades rather than coffee mill type, (used).

1,000 lb. capacity portable platform scales, (used).

Revolvator or portable 10 x 12 ft. tiering machine, overall lifting capacity 1 ton, (used).

N. J., Newark—Butterworth-Judson Corp., Doremus Ave.—machinery for paranitraniline plant.

Fla., Bartow—The Polk County Record, c/o J. G. Gallemore, Editor—new press, linotype machine, etc.

N. C., Greensboro—The Fuller Lumber Co., Inc., shook splicers and wire tying machines.

Mich., Marquette—E. and G. Wickstrom—monorail crane for garage.

Wis., Fond du Lac—The Latex Tire & Rubber Co., c/o G. Lambright, Mgr., East Scott St.—tire and rubber machinery and additional equipment.

Wis., Janesville—C. V. Kerch, City Engs.—crane for pumping station.

Wis., Milwaukee—The Dept. of Pub. Wks., T. Rodgers, chemist—$15,000 worth of special machinery, to be installed in garbage plant, to determine practicability of making alcohol from garbage.

Wis., Milwaukee—The Thiensville Concrete Products Co., c/o A. Meixner, 1429 22d St.—machinery for making drain and sewer tile of concrete, (new).

Wis., Rice Lake—H. Ashlin and S. M. Nelson—woodworking machinery for the manufacture of sash and doors.

Wis., Reeseville—The Reeseville Canning Co.—canning machinery.

Wis., Neillsville—The Neillsville Auto Co. F. Reinhard, Purch. Agt.—small crane for garage purposes.

FOREIGN

Mexico, Monterrey—The Vidriera Monterrey—small grinding machines to face off cast iron molds.

Metal Working

NEW ENGLAND STATES

Conn., Meriden—The Immick Co., State St., will make alterations to its storehouses, build additions to its blacksmith shop and carpenter shop, and also build a 1 story, 55 x 100 ft. garage. Estimated cost, $30,000.

Mass., Boston—The Kneeland St. Garage, Inc., c/o J. C. Spofford, Archt., 36 Bromfield St., plans to construct a 9 story, 30 x 195 ft. garage, on Hudson and Kneeland Sts. Estimated cost, $800,000.

Mass., Lynn—The General Electric Co., 84 State St., has had plans prepared for the construction of a 4 story, 76 x 125 ft. addition to its plant, for the manufacture of electrical goods. Estimated cost, $175,000.

Mass., Palmer—The Springfield St. Ry. Co., 7 North Main St., Springfield, plans to construct a 1 story machine shop, here, to replace the one which was recently destroyed by fire.

Mass., Pittsfield—The Boston & Albany R.R. Co., South Station, Boston, has awarded the contract for the construction of a 1 story, 60 x 95 ft. machine shop. Estimated cost, $25,000.

Mass., Springfield—Chaplin Realty Co., 374 Main St., plans to construct a 1 story, **51 x 245 ft. garage, etc.,** on Pecousic Ave. Estimated cost, $40,000. Private plans.

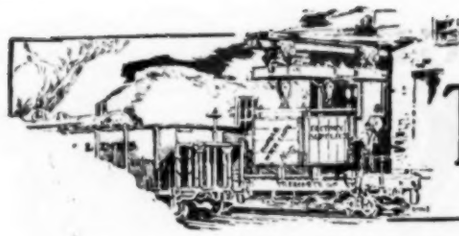
Mass., West Bridgewater—The West Bridgewater Fdry. is building a 50 x 100 ft. iron foundry for the manufacture of iron castings. Estimated cost, $5,000. H. E. Bryant, Supt.

Mass., Worcester—M. Fine, 147 Olean St., is having plans prepared for the construction of a 2 story, 40 x 40 ft. garage on Central St. Estimated cost, $25,000. E. T. Chapin, State Mutual Bldg., Archt.

N. H., Berlin—The Berlin Street Ry. Co. plans to build a 1 story, 50 x 100 ft. addition to its car shop. E. W. Gross, Mgr. Private plans.

R. I., Pawtucket—S. Oziok plans to build a 1 story, 55 x 125 ft. garage and auto repair shop on Main St. Estimated cost, $30,000.

R. I., Providence—The Narragansett Electric Lighting Co., Turks Head Bldg., plans to build a service and storage building on Melrose and Russell Sts. Jenks & Ballou, 1035 Grosvenor Bldg., Archts. and Engrs.



THE WEEKLY PRICE GUIDE

IRON AND STEEL

PIG IRON—Quotations compiled by The Matthew Addy Co.:

CINCINNATI	Current	One Year Ago
No. 2 Southern	$44.50	$30.35
Northern Basic	40 00	27.55
Southern Ohio No. 2	42 00	28.55
NEW YORK—TIDEWATER DELIVERY		
2X Virginia (Silicon 2.25 to 2.75)	51.26	32.40
Southern No. 2 (Silicon 2.25 to 2.75)	48.26	35.20
BIRMINGHAM		
No. 2 Foundry	40 50	29.25
PHILADELPHIA		
Eastern Pa., No. 2x, 2.25-2.75 sil.	42 50	29.00-30.00
Virginia No. 2	46 25	33.10
Basic	38 25	26.75
Grey Forge	40 25	26.75
CHICAGO		
No. 2 Foundry local	40 00	26.75
No. 2 Foundry, Southern	46.66	28.00
PITTSBURGH, INCLUDING FREIGHT CHARGE FROM VALLEY		
No. 2 Foundry	41.96	28.15
Basic	38.00	27.15
Bessemer	38.00	29.35

* F.o.b. furnace. † Delivered.

STEEL SHAPES—The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$3 80	$4 15	$3.47	$3.58	$3.37	$3.58	$3.47
Soft steel bars	3 70	4 15	3.37	3.34	3.27	3.48	3.37
Soft steel bar shapes	3.70	4 15	3.37	3 48	3.27	3.48	3.37
Soft steel bands	4.65	5 50	4.07	6.25	.....	.....	.....
Plates, ¼ to 1 in. thick	4.00	4.15	3.67	3.78	3.57	3.78	3.67

BAR IRON—Prices per 100 lb. at the places named are as follows:

	Current	One Year Ago
Mill, Pittsburgh	$4.25	$2.77
Warehouse, New York	4.75	3.37
Warehouse, Cleveland	3.52	3.27
Warehouse, Chicago	4.12	3.37

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the base quotations from mill:

Blue Annealed	Large Mill Lots Pittsburgh	New York Current	New York One Year Ago	Cleveland	Chicago
No. 10	3 55	5 20	4 57	5 00	6.13
No. 12	3 60	5 25	4 62	5 05	6.18
No. 14	3 65	5 30	4 67	5 10	6.23
No. 16	3 75	5 40	4 77	5 20	6.33
Black					
Nos. 18 and 20	4 20	6 30	5 30	5 60	6.90
Nos. 22 and 24	4 25	6 35	5 35	5 75	6.95
No. 26	4 30	6 40	5 40	5 80	7.00
No. 28	4 35	6 50	5 50	5 90	7.10
Galvanized					
No. 10	4 70	7 05	5 75	6 25	7.25
No. 12	4 80	7 15	5 85	6 35	7.30
No. 14	4 80	7 15	5 85	6 35	7.45
Nos. 18 and 20	5 10	7 40	6 15	6 65	7 75
Nos. 22 and 24	5 25	7 55	6 30	6 80	8.15
No. 26	5 40	7 70	6 45	6 95	8.30
No. 28	5 70	8 00	6 75	7.25	8.60

Acute scarcity in sheets, particularly black, galvanized and No. 16 blue enameled. Automobile sheets are unavailable except in fugitive instances, when prices are 9.45c per lb. for No. 16; 9.50 for Nos. 18 and 20, and 9.55c for Nos. 22 and 24.

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Rounds, drafting or screw stock, per 100 lb. base	$5 50	$5.80	$4.84
Flats, square and hexagons, per 100 lb. base	6.00	6.30	5 34

DRILL ROD—Discounts from list price are as follows at the places named:

	Per Cent.
New York	50
Cleveland	50
Chicago	50

NICKEL AND MONEL METAL — Base prices in cents per pound F.O.B. Bayonne, N. J.

Nickel	
Ingot and shot	43
Electrolytic	45

Monel Metal			
Shot and blocks	35	Hot rolled rods (base)	42
Ingots	38	Cold rolled rods (base)	56
Sheet bars	40	Hot rolled sheets (base)	55
Special Nickel and Alloys			
Malleable nickel ingots			45
Malleable nickel sheet bars			47
Hot rolled rods, Grades "A" and "C" (base)			60
Cold drawn rods, grades "A" and "C" (base)			72
Copper nickel ingots			42
Hot rolled copper nickel rods (base)			52
Manganese nickel hot rolled (base) rods "D" — low manganese			64
Manganese nickel hot rolled (base) rods "D"— high manganese			67

Domestic Welding Material (Swedish Analysis)—Welding wire in 100-lb lots sells as follows, f. o. b. New York: 1/16, 8½c. per lb.; ⅛, 8c.; 3/16 to ¼, 7½c Domestic iron sells at 12c. per lb.

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York Current	Cleveland Current	Chicago Current
Openhearth spring steel (heavy)	7.00	8.00	9.00
Spring steel (light)	10.00	7.00	12.00
Coppered bessemer rods	9.00	8.00	6.75
Hoop steel	4.70	4.04	5.32
Cold-rolled strip steel	9.50	8.25	10.75
Floor plates	6.25	4.00	6.63

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galvanized	Inches	Iron Black	Iron Galvanized
¼ to 3	54-57½%	41½-44%	⅛	15½-25½%	+1½-11½%
			¼	19½-29½%	1½-11½%
			⅜ to 1½	24½-34½%	8 -18½%

LAP WELD

2	47 -50½%	34½-38%	1¼	.....	.....
2½ to 6	50 -53½%	37½-41%	1½	.....	.....
7 to 12	47 -50½%	33½-37%	2	20½-28½%	6½-14½%
13 to 14	37½-41 %	.....	4½ to 6	22½-30½%	9½-17½%
15	35 -38½%	.....	2½ to 4	22½-30½%	9½-17½%
			7 to 12	19½-27½%	6½-14½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

¼ to 1½	52 -55½%	39½-43%	¼ to 1½	24½-34½%	9½-19½%
2 to 3	53 -56½%	40½-44%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	45 -48½%	33½-37%	1¼	.....	.....
2½ to 4	48 -51½%	36½-40%	1½	.....	.....
4½ to 6	47 -50½%	35½-39%	2	21½-29½%	8½-16½%
7 to 8	43 -46½%	29½-33%	2½ to 4	23½-31½%	11½-19½%
9 to 12	38 -41½%	24½-28%	4½ to 6	22½-30½%	10½-18½%
			7 to 8	14½-22½%	2½-10½%
			9 to 12	9½-17½%	5½-+2½%

	New York Black	New York Galv.	Cleveland Black	Cleveland Galv	Chicago Black	Chicago Galv.
¼ to 3 in. steel butt welded	38%	22%	39%	30%	54%40%	40½@30 %
2½ to 6 in. steel lap welded	33%	18%	41%	26%	50@40%	37½@27½%

Malleable fittings. Classes B and C, banded, from New York stock sell at plus 45%. Cast iron, standard sizes, plus 5%.

METALS

MISCELLANEOUS METALS—Present and past New York jobbers' quotations in cents per pound, in quantities up to car lots:

	Current	Month Ago	Year Ago
Copper, electrolytic	15 00	15.00	22.50
Tin in 5-ton lots	34 25	36.25	56.50
Lead	5 375	5.75	6.25
Zinc	7.00	7.00	7.60
ST. LOUIS			
Lead	6.25	7.25	6.00
Zinc	6.75	6.25	7.15

At the places named, the following prices in cents per pound prevail, for 1 ton or more:

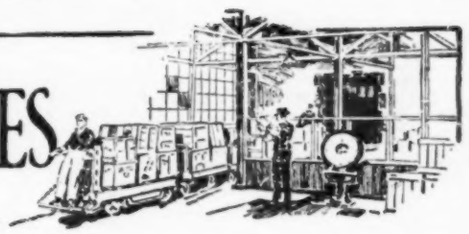
	New York Current	New York Month Ago	New York Year Ago	Cleveland Current	Cleveland Year Ago	Chicago Current	Chicago Year Ago
Copper sheets, base	22.50	22.50	33.50	24.50	35.50	28.50	36.50
Copper wire (carload lots)	17.00	20.00	30.75	22.00	30.50	25.00	26.00
Brass sheets	20.25	22.25	32.00	25 00	33.00	25.25	28.00
Brass pipe	25.00	25.00	36.00	27.00	39.00	30.00	37.00
Solder (half and half) (case lots)	27.75	27.25	45.00	29.00	41.00	22.50	38.50

Copper sheets quoted above hot rolled 24 oz., cold rolled 14 oz. and heavier, add 2c.; polished takes 5c. per sq.ft. extra for 20-in. widths and under; over 20 in., 7½c.

BRASS RODS—The following quotations are for large lots, mill. 1000 lb. and over, warehouse; net extra:

	Current	One Year Ago
Mill	18.25	24.00
New York	18 25	28.00@29 75
Cleveland	23 00	29.00
Chicago	23 25	27 00

SHOP MATERIALS AND SUPPLIES



ZINC SHEETS—The following prices in cents per pound are f.o.b. mill—less 8% for carload lots 11.50

	Warehouse			
	—In Casks—		— Broken Lots —	
	Current	One Year Ago	Current	One Year Ago
Cleveland	15.30	12.50	14.70	13.00
New York	14.00	11.50	14.50	12.50
Chicago	14.50	16.50	14.95	16.00

ANTIMONY—Chinese and Japanese brands in cents per pound, in ton lots for spot delivery, duty paid:

	Current	One Year Ago
New York	6.25	9.50
Chicago	7.00	9.75
Cleveland	7.50	9.75

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	—*New York—			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy, and crucible	12.00	17.00	10.00	11.50
Copper, heavy, and wire	11.50	16.00	9.50	11.00
Copper, light, and bottoms	10.00	14.00	9.00	9.50
Lead, heavy	4.00	4.75	4.00	4.50
Lead, tea	3.00	3.75	3.00	3.50
Brass, heavy	7.00	10.50	7.00	10.50
Brass, light	5.50	7.50	5.00	5.50
No. 1 yellow brass turnings	6.50	10.00	5.50	5.50
Zinc	4.50	5.00	3.00	4.50

*These prices nominal because of dull market

ALUMINUM—The following prices are from warehouse at places named:

	New York	Cleveland	Chicago
No. 1 aluminum, 98 to 99% pure, in ingots for remelting (1-15 ton lots), per lb	29.00	26.00	33.50

COPPER BARS—From warehouse sell as follows in cents per pound, for ton lots and over:

	Current	One Year Ago
New York (round)	28.00	32.00
Chicago	21.00	31.00
Cleveland	25.00	35.00

BABBITT METAL—Warehouse price per pound:

	—New York—		—Cleveland—		— Chicago —	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	70.00	90.00	44.00	70.00	43.00	60.00
Commercial	30.00	50.00	16.50	16.50	11.00	13.00

NOTE—Price of babbitt metal is governed largely by formula, no two manufacturers quoting the same prices. For example, in New York we quote the best two grades, although lower grades may be obtained at from $16 to $20.

SHOP SUPPLIES

NUTS—From warehouse at the places named, on fair-sized orders, the following amount is deducted from list:

	— New York —		— Cleveland —		— Chicago —	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Hot pressed square	+$1.25	$1.50	List net	$2.25	+1.15	1.85
Hot pressed hexagon	+ 1.25	1.50	List net	2.25	+1.15	1.85
Cold punched hexagon	+ 1.25	1.50	List net	2.25	+1.15	1.30
Cold punched square	+ 1.25	1.50	List net	2.25	+1.15	1.30

Semi-finished nuts, ⅞ and smaller, sell at the following discounts from list price:

	Current	One Year Ago
New York	30%	50-10%
Chicago	40%	50%
Cleveland	50%	55%

MACHINE BOLTS—Warehouse discounts in the following cities:

	New York	Cleveland	Chicago
½ by 4 in. and smaller	+10%	50%	20%
Larger and longer up to 1½ in. by 30 in.	Net list	40%	10%

WASHERS—From warehouses at the places named the following amount is deducted from list price:

For wrought-iron washers:

New York..... list Cleveland ..... $2.75 Chicago..... $1.90

For cast-iron washers, ⅜ and larger, the base price per 100 lb. is as follows:

New York..... $7.00 Cleveland..... $4.50 Chicago..... $5.50

CARRIAGE BOLTS—From warehouses at the places named the following discounts from list are in effect:

	New York	Cleveland	Chicago
½ by 6 in. and smaller	+20%	40%	30%
Larger and longer up to 1 in. by 30 in.	+20%	35%	15%

COPPER RIVETS AND BURS sell at the following rate from warehouse:

	Rivets		Burs	
	Current	One Year Ago	Current	One Year Ago
Cleveland	25%	20%	10%	10%
Chicago	net	20%	net	20%
New York	30%	40%	net	20%

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅛ and smaller	20%	50%	30%
Tinned	20%	50%	30%

Structural, same sizes:

New York..... $5.73 Chicago..... $5.75 Pittsburgh..... $4.50

Boiler, ½, ⅝, 1 in. diameter by 2 to 5 in. sell as follows per 100 lb.:

New York..... $6.00 Chicago..... $5.83 Pittsburgh..... $4.60

MISCELLANEOUS

SEAMLESS DRAWN TUBING—The base price in cents per pound from warehouse in 100-lb. lots is as follows:

	New York	Cleveland	Chicago
Copper	26.00	30.00	31.00
Brass	25.00	27.00	30.00

The prices, of course, vary with the quantity purchased. For lots of less than 100 lb., but not less than 75 lb., the advance is 1 c.; for lots of less than 75 lb., but not less than 50 lb., 2½c. over base (100-lb. lots); less than 50 lb., but not less than 25 lb., 5c. should be added to base price; quantities from 10-25 lb., extra is 10c.; less than 10 lb., add .15–20c.

Double above extras will be charged for angles, channels and sheet metal mouldings if ordered in above quantities. Above extras also apply to brass rod other than standard stock sizes—stock sizes being considered as ½-2 in. inclusive in rounds, and ½-1½ in., inclusive, in square and hexagon—all varying by thirty seconds up to 1 in. by sixteenths over 1 in. On shipments aggregating less than 100 lb., there is usually a boxing charge of $1.50.

LONG TERNE PLATE—In Chicago No. 28 primes from stock sell, nominally, for $8.85 per 100 lbs.

In Cleveland—$10 per 100 lbs.

COTTON WASTE—The following prices are in cents per pound:

	— New York —			
	Current	One Year Ago	Cleveland	Chicago
White	13.00@15.00	13.00	15.00	15.00@17.00
Colored mixed	7.00@12.00	9.00–12.00	11.00	11.00@13.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½x13½	13½x20½
Cleveland	55.00	65.00
Chicago	41.00	43.50

SAL SODA sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$2.00	$2.00	$1.75
Philadelphia	2.75	2.75	1.75
Cleveland	4.00	3.00	2.50
Chicago	2.00	2.75	2.00

ROLL SULPHUR in 360-lb. bbl. sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$3.50	$3.50	$3.65
Philadelphia	3.65	3.65	3.87
Chicago	3.85	3.85	4.12½

COKE—The following are prices per net ton at ovens, Connellsville:

	January 3	December 27	December 20
Prompt furnace	$6.00@$7.00	$7.00@$7.50	$7.00@$7.50
Prompt foundry	7.00@8.00	8.50@9.00	8.50@9.00

FIRE CLAY—The following prices prevail:

		Current
Ottawa, bulk in carloads	Per Ton	$8.00
Cleveland	100-lb. bag	1.00

LINSEED OIL—These prices are per gallon:

	—New York—		—Cleveland—		—Chicago—	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Raw in barrels, (5 bbl. lots)	$0.90	$2.15	$1.05	$2.50	$1.01	$2.37
5-gal cans	1.05	2.30	1.30	2.75	1.26	2.57
1-gal cans (6 to case)	1.15					

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		One Year Ago		Current	One Year Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100 lb. keg	14.00	15.50	13.00	14.50	14.00	13.00
25 and 50-lb. kegs	14.25	15.75	13.25	14.75	14.25	13.25
12½-lb. keg	14.50	16.00	13.50	15.00	14.50	13.50
5-lb. cans	17.00	18.50	15.00	16.50	17.00	15.00
1-lb. cans	19.00	20.50	16.00	17.50	19.00	16.00

500 lb. lots less 10% discount. 2,000 lb. lots less 10 4% discount. 10,000 lb. lots less 10 7½% discount

MIDDLE ATLANTIC STATES

Md., Baltimore—The Morton McI. Dukehart & Co., 641 Light St., will soon award the contract for the construction of a 1 story, 40 x 125 ft. machine shop, which will probably include a foundry. Estimated cost, $30,000. W. H. Emory, Jr., Munsey Bldg., Archt.

N. J., East Orange—The Jephson Scott Body Co., 24 Sterling St., has awarded the contract for the construction of a 2 story, 58 x 63 ft. factory. Estimated cost, $70,000. Noted Dec. 2.

N. J., Orange—I. Blum & Co. plans to construct a 1 story, 57 x 223 ft. garage and store building at 100-102 Main St. Estimated cost, $75,000.

N. J., Orange—The D. & H. Constr. Co. plans to build a 1 story, 55 x 164 ft. garage at 209-211 Main St. Estimated cost, $26,000. Kruger & Siegler, Archts.

N. Y., New York (Borough of Brooklyn)—R. Embers, 209 King St., has awarded the contract for the construction of a 1 story, 60 x 100 ft. foundry on Richards St. Estimated cost, $35,000.

N. Y., New York (Borough of Brooklyn)—J. P. Riorden, 431 West 14th St., New York City, will build a 1 story, 100 x 160 ft. garage at 239 South St. Estimated cost, $40,000.

N. Y., New York (Borough of Brooklyn)—J. Schwartz, c/o M. Hirsh, Archt. and Engr., 26 Court St., will build a 1 story, 135 x 140 ft. garage on Abermarle Rd. near Flatbush Ave. Estimated cost, $50,000.

N. Y., New York (Borough of Brooklyn)—B. Slater, 175 Bay 29th St., will build a 1 story garage on Atlantic Ave. and Clinton Ave. Estimated cost, $60,000. McCarthy & Kelley, 16 Court St., Archts. and Engrs.

N. Y., New York (Borough of Brooklyn)—The Webster Bldg. Co., 290 Saratoga Ave., will build a 1 story, 150 x 200 ft. garage on Myrtle Ave. near McKibbon St. Estimated cost, $75,000.

Pa., Ambridge—The Columbia Steel Shafting Co., Park Bldg., Pittsburgh, is having preliminary plans prepared for the construction of a 1 and 2 story, 600 x 600 ft. factory, here. Estimated cost, $1,000,000. L. C. Horn, 1505 Park Bldg., Pittsburgh, Engr.

Pa., Philadelphia—Edelstein & Bernstein, 434 Widener Bldg., have awarded the contract for the construction of a 1 story, 86 x 128 ft. garage. Estimated cost, $30,000.

Pa., Philadelphia—The General Baking Co. is having plans prepared for the construction of a garage on Reed and Percy Sts. Potts Bros. & Cooperson, 129 North 11th St., Archts.

Pa., Philadelphia—The Jump House Wrecking Co., 30th St. below Callowhill St., will build a 1 and 2 story, 20 x 40 ft., 40 x 80 ft., 11 x 30 ft. and 26 x 60 ft. office, storage, garage and repair buildings, on 43d and Woodland Sts.

Pa., Philadelphia—F. A. North, 1306 Chestnut St., is having plans prepared for the construction of a 4 story, 28 x 177 ft. warehouse and garage at 1529 Parrish St. A. W. Barnes, 10 South 18th St., Archt.

Pa., Pittsburgh—The Simons Co., 824 River Ave., manufacturers of beds, will soon award the contract for the construction of a 2 story factory, to cover 23,000 sq ft. of floor space, on River and Madison Aves. Private plans.

SOUTHERN STATES

Tenn., Etowah—The Louisville & Nashville R.R., Knoxville, plans to rebuild repair shops and machinery department building which was recently destroyed by fire. Estimated loss, $150,000. W. H. Courtney, Ch. Engr.

MIDDLE WEST STATES

Ind., Anderson—The Indiana Tractor & Silo Co. will build a 1 story, 100 x 200 ft. tractor plant. Estimated cost, $60,000.

Mich., Detroit—The Zenith Fdry. Co., Miller Ave. has awarded the contract for the construction of a 1 story, 90 x 200 ft. foundry.

O., Cleveland—The Hill Clutch Co., foot of West 65th St., is building a 1 story, 26 x 42 ft. addition to its factory. Estimated cost, $10,000.

O., Cleveland—M. Purer, 2724 East 53d St., has awarded the contract for the construction of a 1 story, 80 x 120 ft. garage at 796 East 105th St. Estimated cost, $40,000. Noted Dec. 16.

O., Dayton—The Lucas Miner Tool & Production Co., Valley St., plans to remodel and equip a 3 story factory at 427 Valley St. for the manufacture of fire sprinklers. Estimated cost, $25,000.

Wis., Wisconsin Rapids—The Amer. Rotary Engine Co. is having plans prepared for the construction of a 1 story machine shop. Estimated cost, $25,000. J. A. Cohen, Treas. LaSalle Eng. Co., 337 West Madison St., Chicago, Engrs.

WEST OF THE MISSISSIPPI

Minn., Minneapolis—The City is having plans prepared for the construction of a 2 story, 60 x 90 ft. police station to include a 1 story, 34 x 57 ft. repair shop on Bryant Ave., S., and 29th St. Total estimated cost, $100,000. J. F. Walker, Supt. of the Police. Bertrand & Chamberlin, 616 Northwestern Bank Bldg., Archts.

Tex., Amarillo—The Fort Worth & Denver Ry., Denver Record Bldg., Ft. Worth, has authorized the expenditure of $200,000 to improve shops and yards, here, including new machinery, etc. Address F. E. Clarity, Vice-Pres. and Genl. Mgr.

WESTERN STATES

Cal., Los Angeles—The Catholic Bishop of Monterey and Los Angeles, Higgins Bldg., has awarded the contract for the construction of a 1 story, 60 x 176 ft. addition to his garage. Estimated cost, $21,500.

Cal., Los Angeles—The Consolidated Vanadium Co., 1225 Washington Bldg., has awarded the contract for the construction of a 1 story, 50 x 50 ft. factory. W. S. Green, Los Angeles, Engr.

CANADA

Ont., London—The Service Truck Co., Wabash, Ind., plans to build a 1 story, 100 x 300 ft. factory, here. Estimated cost, $100,000.

General Manufacturing

NEW ENGLAND STATES

Conn., New Haven—The Connecticut Sash & Door Co., 451-59 Grand Ave., will build a 4 or 5 story factory to replace the one which was recently destroyed by fire. Estimated cost, $75,000.

Mass., Huntington—The Chapin & Gould Paper Co. has awarded the contract for remodeling its paper plant.

Mass., Pittsfield—The Boston & Albany R.R., South Sta., Boston, plans to construct a 1 story roundhouse at its yards, here, to replace the one which was recently destroyed by fire.

Mass., Southbridge—The Crown Confectionery Co., 89 Main St., plans to construct a 3 story, 50 x 60 ft. candy factory. Estimated cost, $10,000.

R. I., Westerly—The Westerly Textile Co., 41 Main St., plans to build a 2 story addition to its textile plant. Estimated cost, $50,000. C. T. Main, 201 Devonshire St., Boston, Engr.

MIDDLE ATLANTIC STATES

N. J., Newark—The Butterworth—Judson Corp., Doremus Ave., has had plans prepared for the construction of a 3 story paranitraniline plant to replace the one which was recently destroyed by fire. Estimated cost, $180,000.

N. J., Ridgefield—The Continental Paper Box Co., 122 Washington St., Brooklyn, has awarded the contract for the construction of a 100 x 500 ft factory on Grand Ave. and Hale St., here. Estimated cost, $250,000.

SOUTHERN STATES

Fla., Bartow—The Polk County Record, c/o J. G. Gallemore, Editor, will soon award the contract for the construction of a 2 story, 50 x 75 ft. newspaper plant. Estimated cost, $75,000. B. C. Bonfoey, Tampa, Archt.

Fla., Lake Alfred—The Lake Alfred Citrus Growers Assn. has awarded the contract for the construction of a 2 story, 200 x 200 ft. packing house. Estimated cost, $100,000.

Ky., Louisville—G. M. Clark, New Albany, Ind., has awarded the contract for the construction of a 1 story, 95 x 115 ft. building on 21st and Howard Sts. The Natl. Biscuit Co., lessee.

Ky., Louisville—The F. A. Minne factory of the Natl. Candy Co. is having plans prepared for the construction of a 5 story, 135 x 216 ft. factory. Estimated cost, $600,000. D. X. Murphy & Bros., Louisville Trust Bldg., Archts.

MIDDLE WEST STATES

O., Cleveland—The Arnold Woodenware Co., 1369 West 9th St., plans to build a 2 story, 50 x 150 ft. factory on West 53d St. and Detroit Ave. Estimated cost, $100,000. R. H. Ellsworth, Mgr.

O., Cleveland—The City Ice Delivery Co., Cadillac Bldg., plans to build a 1 story, 65 x 140 ft. ice factory and storage room on Saranac Rd. Estimated cost, $75,000. H. D. Morval, Mgr. C. C. Coneby, Cadillac Bldg., Engr. and Archt.

O., Sandusky—The Hord Color Products Co., South Columbus Ave., manufacturer of paint, has awarded the contract for the construction of a 1 story factory. Estimated cost, $50,000.

Wis., Fond du Lac—The Latex Tire & Rubber Co., c/o G. Lambright, Mgr., is building a 2 story, 60 x 178 ft. tire factory, on East Scott St. Estimated cost, $40,000. R. E. Mehner, Fond du Lac, Archt. Noted Dec. 30.

Wis., Reeseville—The Reeseville Canning Co. plans to build a 4 story, 60 x 185 ft. canning factory on Main St. Estimated cost, $75,000.

Wis., Thiensville—The Thiensville Concrete Products Co., c/o A. Meixner, 1429 22d St., Milwaukee, plans to build a 1 story addition to its factory.

WEST OF THE MISSISSIPPI

Okla., Oklahoma City—The Amer. Legion is having preliminary plans prepared for the construction of a group of hospital buildings, to include a laundry and garage, etc. Total estimated cost, $2,000,000. C. Needer and M. Jayne, Empress Theatre Bldg., Archts.

Tex., Dallas—The Gulf Refining Co., 315 Sherman St., has awarded the contract for the construction of several 1 and 2 story buildings to cover 40,000 sq.ft. of floor space. Cost between $150,000 and $200,000. Noted Nov. 4.

CANADA

B. C., Kitimat—The Kitimat Pulp & Paper Co. has made application to the Provincial Government of British Columbia for water privileges in connection with the establishment of a proposed pulp and paper mill at Lowe Inlet, Kitimat Arm.

Que., Sorel—M. J. Dansereau will receive bids in January for the construction of a pulp mill, to have a daily capacity of 100 tons of pulp. Estimated cost $500,000.